DOCUMENT RESUME

ED 137 629 08 CE 011 063

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TITLE	A Study of Job Demands and Curriculum Development in Agricultural Training Related to the Muskegon County Wastewater Management System. Final Report. Volume III. Student Terminal Performance Objectives and Instructional Modules.
INSTITUTION	Muskegon Area Intermediate School District, Mich.
SPONS AGENCY	Bureau of Occupational and Adult Education (DHEW/OE), Washington, D.C.
BUREAU NO	V0218VZ
PUB DATE	Jan 76
GRANT	OEG-0-74-1669
NOTE	889p.; For related documents see CE 010 459 and CE 011 062-064
EDRS PRICE	MF-$1.67 HC-$47.55 Plus Postage.
DESCRIPTORS	Agricultural Education; Agricultural Machinery Occupations; *Agricultural Occupations; Agricultural Research Projects; Agricultural Technicians; *Behavioral Objectives; Curriculum Development; Farm Management; Farm Occupations; Job Skills; Junior Colleges; Laboratory Technology; Land Use; *Learning Modules; Off Farm Agricultural Occupations; Secondary Education; *Skill Development; Technical Education; Vocational Development; *Waste Disposal; *Water Pollution Control; Water Resources
IDENTIFIERS	*Michigan; Michigan (Muskegon County)

ABSTRACT

This is the third volume of a four-volume report of a research project designed to (1) identify job needs for agricultural occupations which will result from the Muskegon County Wastewater Management System and perform a task analysis on each occupation, (2) develop instructional modules and determine their place in either high school or 2-year college programs, and (3) implement an articulated curriculum with actual programs. This volume focuses on the second objective--student performance objectives and instructional modules. Performance objectives are presented for each of the eight occupations identified in relation to wastewater management systems: Wastewater treatment operator, wastewater treatment laboratory technician, agricultural equipment mechanic, farm equipment operator, farm manager, field supervisor, irrigator, and grain drier operator. The performance objectives are presented in a four-column format which also includes a corresponding instructional module topic, learning conditions, and criteria. Sets of instructional modules, or examples of modules, for the eight occupations constitute over half the document. Each module contains a module concept, prerequisites, module goal, corresponding student performance objective, instructional areas, and examples of supporting references, student learning activities, and evaluation techniques. The four appendixes contain information related to the development of the objectives and modules. (SH)

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FINAL REPORT

VOLUME III OF IV VOLUMES - STUDENT TERMINAL PERFORMANCE OBJECTIVES AND INSTRUCTIONAL MODULES

PROJECT NO. V0218VZ
GRANT NO. OEG-0-74-1669

A STUDY OF JOB DEMANDS AND CURRICULUM DEVELOPMENT IN AGRICULTURAL TRAINING RELATED TO THE MUSKEGON COUNTY WASTEWATER MANAGEMENT SYSTEM

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JANUARY, 1976

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PREFACE

This volume is one of four volumes prepared by staff in the Vocational Education Department, Muskegon Area Intermediate School District, as a part of the research project entitled, "A Study of Job Demands and Curriculum Development in Agricultural Training Related to the Muskegon County Wastewater Management System." The project was funded under a contract with the Bureau of Occupational and Adult Education, U.S. Office of Education. The final Report consists of the following volumes:

Volume I:	An Overview of the Research Project
Volume II:	Task Analysis Results
Volume III:	Student Terminal Performance Objectives and Instructional Modules
Volume IV:	Career Awareness Information

Citizens in Muskegon County, Michigan were fortunate in the late 1960's to receive federal, state and local dollars for the construction of a 40+ million dollar "Demonstration" wastewater treatment system. It was the opinion of many concerned individuals that a wastewater land treatment system would stimulate the Muskegon economy and restore lakes, streams, and rivers to a condition of purity most Americans had almost given up the hope of achieving. The research project grew out of a need to identify the jobs and training needs of individuals desiring to work in wastewater land treatment systems and related agricultural occupations. It was anticipated that hundreds of new agricultural related jobs would emerge in the region as a result of the Muskegon farm irrigation system.

The purposes of this project were: (1) To identify job needs for agricultural occupations which will result from the Muskegon County Wastewater Management System and perform a task analysis on each occupation; (2) To develop instructional modules and determine their place in either high school or two-year college programs; and (3) Implement an articulated curriculum with actual programs and gain approval for funding.

ACKNOWLEDGEMENTS

Since the inception of the project, many persons have made significant contributions to the development of the materials included in the final report. Appreciation is expressed to Jack A. Wilson, Project Officer, Research Branch, Division of Research and Demonstration, Bureau of Occupational and Adult Education, U.S. Office of Education, for his direction during the preparation of this information. Gratitude is also expressed to the many local, state, and national agency representatives and industries who have given invaluable assistance in this project.

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INTRODUCTION

The demands for improving our educational system appear to be steadily increasing. Various groups throughout the United States are demanding that students leaving educational institutions at various levels be properly prepared for entry into the real world of work or to pursue further training. Needless to say experienced as well as inexperienced educators who are primarily responsible for classroom teaching must continue to execute instructional methods that will aid in meeting the demands of a disenchanted society. An effective teacher is one who knows what to teach and what methods should be used to reach certain outcomes. Many articles and books are available on performance objectives, while other materials are available on planning a course of study. One objective of the research project was to develop student terminal performance objectives and instructional modules. Such information is included in this volume of the final report.

Student Terminal Performance Objectives

Using the task analysis results, the research team developed student terminal performance objectives for each of the agricultural occupations identified in Muskegon County Wastewater Management System. The occupations included in the study are as follows:

a. Wastewater Treatment Operator

b. Wastewater Treatment Laboratory Technician

c. Agricultural Equipment Mechanic

d. Farm Equipment Operator

e. Farm Manager

f. Field Supervisor

g. Irrigator

h. Grain Drier Operator

In the early 1970's, the Michigan Department of Education spent a portion of its educational monies for the development of student performance objectives. The format used by the Vocational and Career Development Service in writing student performance objectives was adopted for preparing performance objectives for this project. This format is shown in Appendix A, page 654. Student terminal performance objectives depicted in this document outline specifically: (a) The conditions under which the student will perform; (b) What the student will do as a result of the instructional module; and (c) How well the student will perform. Student terminal performance objectives developed by the staff were reviewed by a teacher educator, instructors of vocational agriculture, and several community college instructors who taught environmental chemistry, field biology and ecology, and welding. Comments received from reviewers were considered by the staff in revising the performance objectives. See Appendix B, page 656 for a listing of the reviewers. A complete set of student performance objectives can be located in this volume as indicated below:

Occupational Titles	Page
Wastewater Treatment Operator	
Wastewater Treatment Laboratory Technician	
Agricultural Equipment Mechanic	
Farm Equipment Operator	
Farm Manager	
Field Supervisor	
Irrigator	
Grain Drier Operator	

Instructional Modules

The staff was confronted with the task of designing a delivery system for developing instructional modules. A format for writing instructional modules was developed by the research team and reviewed by several individuals who are knowledgeable in the area of curriculum development. The format for writing instructional modules was designed to provide enough flexibility so that each individual user could adopt materials appropriate to his/her own style and situation. The instructional strategy was also designed so that when certain skills and knowledges become obsolete, such information could be deleted and new information incorporated. Appendix C, pages 658-660 explains the various components in the modules.

Several public and private agencies supplied the staff with an abundance of technical information. See Appendix D, Page 661 to 664 for a listing of the agencies who provided the staff with materials related to this project. With the use of some excellent information, instructional modules were written for some of the occupations studied. Instructional modules developed as a result of the task analysis results are shown on pages 232 to 653. Modules were reviewed by several experts (See Appendix B for listing of reviewers). Each module was revised based on comments received from reviewers.

We are of the opinion that the materials included in this document are useable and should assist those responsible for classroom instruction in preparing students for the real world of work. However, the reader should take note that the student terminal performance objectives and instructional modules have not been tested.

LIST OF MODULE TITLES AND STUDENT PERFORMANCE OBJECTIVES FOR PREPARING WASTEWATER TREATMENT OPERATORS

DETERMINING OCCUPATIONAL OPPORTUNITIES AND SECURING EMPLOYMENT IN WASTEWATER TREATMENT SYSTEMS

USING SAFETY PRACTICES IN OPERATING WASTEWATER TREATMENT SYSTEMS

INTERPRETING CODES, CONTRACTS AND POLLUTION STANDARDS IN OPERATING WASTEWATER TREATMENT SYSTEMS

DETERMINING CHARACTERISTICS OF WASTEWATER

WATER AND WASTEWATER DISEASE TRANSMITTAL

USING GOOD HOUSEKEEPING TECHNIQUES IN OPERATING WASTEWATER TREATMENT SYSTEMS

USING BASIC MATHEMATICS IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS

APPLYING BASIC CHEMISTRY IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS

COLLECTING AND TRANSPORTING WASTEWATER TO DESIGNATED SITE

OPERATING, SERVICING AND REPAIRING AERATORS

OPERATING, SERVICING AND REPAIRING MIXERS

DISINFECTING AND CHLORINATING EFFLUENT

STORING EFFLUENT AND MAINTAINING STORAGE LAGOONS

IRRIGATING WITH EFFLUENT

COLLECTING WASTEWATER SAMPLES

KEEPING RECORDS AND WRITING REPORTS IN WASTEWATER TREATMENT SYSTEMS

USING PUBLIC RELATIONS IN WASTEWATER TREATMENT SYSTEMS

ACQUIRING AND USING GOOD HUMAN RELATION SKILLS WHILE WORKING IN WASTEWATER TREATMENT SYSTEMS

MANAGING AND SUPERVISING EMPLOYEES IN WASTEWATER TREATMENT SYSTEMS

CONTROLLING INSECTS AND RODENTS IN WASTEWATER TREATMENT SYSTEM BUILDINGS

SURVEYING LAND

USING APPLIED HYDRAULICS IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING OCCUPATIONAL OPPORTUNITIES AND SECURING EMPLOYMENT IN WASTEWATER TREATMENT SYSTEMS	1. In seeking information about job opportunities in wastewater treatment systems	the student will conduct personal surveys or obtain literature	that will assist him or her in determining the number and kind of job opportunities which are available in systems where wastewater is treated
	2. Given a specific occupation which the student is interested in	the student will determine the competencies and educational requirements	needed by persons to enter and advance in that career
	3. Upon identifying a job in which the student is interested	the student will follow the proper procedures necessary	to be placed in the job

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING SAFETY PRACTICES IN OPERATING WASTEWATER TREATMENT SYSTEMS	1. While touring or working in the building of a wastewater treatment system	the student will: a. Verbally identify safety equipment by their common names and explain their uses b. Give verbal reasons why the equipment is located in various areas in the building	according to the manufacturer's identification of equipment
	2. Given several objects to be relocated in a wastewater treatment system	the student will mechanically relocate the objects	in the designated area without damaging the objects or mechanical equipment, or injuries to workers
	3. When visiting a collection and pumping station	the student will identify and verbally explain the types and locations of hazardous conditions at the sites	as specified by the employer and to the satisfaction of the instructor
	4. While visiting the aeration treatment cell site	the student will identify and verbally explain the types and locations of hazardous conditions	as specified by the employer and to the satisfaction of the instructor
	5. While visiting the storage and disinfection sites	the student will identify and verbally explain the types and locations of hazardous conditions on the site	as specified by the employer and to the satisfaction of the instructor

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Operator

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING SAFETY PRACTICES IN OPERATING WASTEWATER TREATMENT SYSTEMS	6. While visiting the spray irrigation area	the student will identify and verbally explain the types and locations of hazardous conditions	as specified by the employer and to the satisfaction of the instructor
	7. Given a simulated accident on the wastewater treatment site	the student will properly file an accident report	according to the actual occurance
	8. When visiting the workshop area of the wastewater treatment system	the student will identify and explain the types and locations of hazardous conditions on the site	as specified by the employer and to the satisfaction of the instructor

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INTERPRETING CODES, CONTRACTS, AND WATER POLLUTION STANDARDS IN OPERATING WASTEWATER TREATMENT SYSTEMS	1. Given various contracts relating to wastewater treatment systems	the student will read and interpret the contracts verbally or in writing	so well that the interpretations of the contracts meet the approval of the instructor.
	2. Given various codes relating to wastewater treatment systems	the student will read and interpret the codes verbally or in writing	so well that the interpretations of the codes meet the approval of the instructor.
	3. Given access to various types of water pollution standards	the student will read and interpret the standards verbally or in writing	so well that the interpretations of the water pollution standards meet the approval of the instructor.

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING CHARACTERISTICS OF WASTEWATER	1. Given various samples of wastewater to be measured	the student will accurately measure the samples for their physical characteristics	95% of the samples should be measured for physical characteristics according to given directions
	2. Upon completion of receiving pertinent instructions	the student will explain verbally or in writing chemical characteristics of wastewater and their effects	according to information in appropriate reference
	3. Given access to appropriate equipment, reagents and samples of wastewater	the student will accurately measure	95% of the samples given for the concentrations of solids, BOD, pH and nitrogen

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
WATER AND WASTEWATER DISEASE TRANSMITTAL	1. Given the task of explaining several water and wastewater diseases transmitted by air and their effects	students will explain verbally or in writing the given types of diseases and their effects on humans and animals	according to appropriate reference material
	2. Given the task of explaining several water and wastewater diseases transmitted by food, water, solids and their effects	students will explain verbally or in writing the given types of diseases and their effects on humans and animals	according to appropriate reference material
	3. Given the task of explaining several water and wastewater diseases transmitted by insects, animals and their effects	students will explain verbally or in writing the given types of diseases and their effects on humans and animals	according to appropriate reference material

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
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Occupational
Designation: Wastewater Treatment Operator

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NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING GOOD HOUSEKEEPING TECHNIQUES IN OPERATING WASTEWATER TREATMENT SYSTEMS	1. Given access to wastewater treatment system buildings,	the student will organize equipment, clean and maintain buildings	to the satisfaction of the instructor and so that they are attractive and safe for working.
	2. Given access to wastewater treatment system grounds which surround buildings, equipment and lagoons,	the student will clean and maintain the grounds	to the satisfaction of the instructor and so that they are attractive and safe for working.

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING BASIC MATHEMATICS IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS	1. Given areas to be calculated and materials for making calculations	the students will accurately calculate	95% of the areas given
	2. Given volumes to be calculated and materials for making calculations	the student will accurately calculate	95% of the volumes given
	3. Given the task of calculating velocity and rate of flow	the student will accurately calculate	95% of the velocity and rate of flow mathematical problems given
	4. Given the task of calculating weight relationships	the student will calculate	95% of the weight relationships given
	5. Given accurate information regarding wastewater treatment systems and a given number of efficiency problems to be calculated	the student will accurately calculate	95% of the plant efficiency problems given
	6. Given the task of calculating basic mathematical problems	the student will convert measurements of the English system to the metric system and calculate	95% of the mathematical problems given

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Operator

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING BASIC MATHEMATICS IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS	7. Given accurate information and basic mathematical problems related to wastewater treatment systems	the student will use steps necessary in accurately solving	95% of the mathematical problems given

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MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Operator

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NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
APPLYING BASIC CHEMISTRY IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS	1. Given the task of identifying symbols and formulas of chemicals used in wastewater treatment systems,	the student will identify the symbols and formulas with the elements and compounds they represent verbally or in writing	with 95% accuracy
	2. Given equations of chemical reactions used in wastewater treatment systems,	the student will calculate the amounts of reactants needed to produce the desired amounts of products to the correct number of significant figures	as determined by the given data
	3. Given chemical reactions of acids and bases as they relate to the treatment of wastewater	the student will calculate the amounts of acid (base) necessary to neutralize the bases and acids to the correct number of significant figures	as determined by the given concentration of acid (base) and the apparatus appropriate for the determination in wastewater treatment
	4. Given a range of pH to be investigated in an acid base titration	the student will pick an appropriate indicator	as determined by accepted chemical practice.

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
COLLECTING AND TRANSPORTING WASTEWATER TO DESIGNATED SITE	1. Given blue prints of a sewer system	the student will interpret and explain verbally the sewer designs and construction	according to terminology used in interpreting sewer design and construction
	2. While working in a wastewater treatment system	the student will inspect the conditions of sewer systems and correct problems related to laterals and mains	so well that the system operates efficiently
	3. Given access to various sizes and types of pumps and necessary maintenance equipment	the student will verbally explain the operation of, maintain and operate the pumps	according to operator's manual
	4. Given various sizes and types of motors	the student will verbally explain the operation of, maintain and operate the motors	according to the operator's manual
	5. Given access to the electrical power system in a wastewater lift station	the student will verbally explain and maintain the system	according to operator's manual
	6. Given access to the metering devices used at wastewater treatment systems	the student will read the meters and verbally interpret the readings	according to the terminology used in interpreting meters used in wastewater treatment systems

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Operator

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
COLLECTING AND TRANSPORTING WASTEWATER TO DESIGNATED SITE	7. When visiting a lift station	the student will identify the parts of the station and verbally explain their operations	according to the operating manual

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NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
OPERATING, SERVICING AND REPAIRING AERATORS	1. Given access to an aerator and repair manual	the student will identify the component parts and describe verbally or in writing the functions of each component	according to information in given service manual
	2. Given access to an aerator in a wastewater treatment system	the student will operate the equipment	according to operator's manual
	3. Given access to an aerator and the appropriate service equipment	the student will service the equipment	according to service manual
	4. Given an aerator, appropriate manual, tools and equipment	the student will disassemble the equipment, repair and reassemble the equipment	according to repair manual

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
OPERATING, SERVICING AND REPAIRING MIXERS	1. Given access to a mixer and repair manual	the student will identify the component parts and describe verbally or in writing the functions of each component	according to information in given manual
	2. Given access to a mixer in a wastewater treatment system	the student will operate the equipment	according to operator's manual
	3. Given access to a mixer and the appropriate service manual	the student will service the equipment	according to service manual
	4. Given access to a mixer	the student will disassemble the equipment, repair and reassemble the equipment	according to repair manual

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Operator

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NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DISINFECTING AND CHLORINATING EFFLUENT	1. Given the task of explaining the principles of chlorination in treating waste	the student will explain verbally or in writing the principles of chlorination in treating waste	according to appropriate reference materials
	2. While visiting a wastewater treatment chlorination system	students will identify the basic equipment in the system by their common names and explain verbally or in writing their operating principles	according to appropriate reference materials
	3. While working in a wastewater treatment chlorination system	the student will identify chlorine safety equipment, and demonstrate safety procedures in working with chlorination equipment and materials	according to operating manual
	4. Given access to chlorination system	the student will service the equipment	as recommended by the manufacturer to maintain the equipment in an efficient working condition
	5. Given the appropriate equipment and reagents	the student will follow directions in measuring chlorine residue	with 95% accuracy and according to the procedures in given manual

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
STORING EFFLUENT AND MAINTAINING STORAGE LAGOONS	1. After receiving appropriate instruction	the student will explain verbally or in writing the biological processes that occur in storage lagoons	according to appropriate reference materials
	2. Given blue prints of a lagoon	the student will verbally explain the lagoon design as specified in the blue print	by using terminology in appropriate reference
	3. While working in a wastewater treatment system	the student will operate and maintain a storage lagoon	according to management request so that the system operates effectively, and is safe for working and attractive to visitors

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Operator

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
IRRIGATING WITH EFFLUENT	1. Given access to a field crop being irrigated	the student will explain verbally or in writing the benefits and disadvantages of using effluent for irrigating crops	according to local agronomic reports
	2. Given access to effluent sprinkler irrigation equipment	the student will identify the components and verbally describe their functions	according to the manufacturer's manual
	3. Given access to effluent sprinkler irrigation equipment	the student will operate the equipment	according to operator's manual
	4. Given access to effluent sprinkler irrigation equipment and service equipment	the student will service the equipment	according to the manufacturer's specifications
	5. Given access to effluent sprinkler irrigation equipment and repair tools	the student will troubleshoot and make minor repairs on the equipment	according to manufacturer's procedures and directions

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Operator

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
COLLECTING WASTEWATER SAMPLES	1. Upon completion of receiving instruction on pertinent information	the student will explain verbally or in writing the importance of accurately collecting samples of wastewater in a wastewater treatment system	according to reference materials
	2. Given the task of collecting wastewater samples	the student will select and use appropriate sampling equipment in collecting samples	according to correct procedures in appropriate reference manual

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MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Operator

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
KEEPING RECORDS AND WRITING REPORTS IN WASTEWATER TREATMENT SYSTEMS	1. Given access to the records of a wastewater treatment system	the student will organize, maintain, locate and evaluate records	so well that information can be located when needed in a reasonable period of time and the performance of the operation accurately determined
	2. Given the task of writing and presenting a technical report of a wastewater treatment system	the student will organize, write and present a report	so well that the report is accurate and understood by listeners

Occupational
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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING PUBLIC RELATIONS IN WASTEWATER LAND TREATMENT SYSTEMS	1. Given the task of showing and explaining the wastewater treatment system to a group	the student will plan and conduct the tour	so well that the tour is conducted in a safe and organized manner and the visitors clearly understand the system after touring
	2. Given the task of preparing and presenting a speech	the student will prepare and present a speech on behalf of a wastewater treatment system	so well that the speech is clear and understood by the listeners
	3. Given the appropriate materials	the student will prepare the following: a. News releases b. Bulletins c. Newsletters d. Photographs	so well that the information is accurate and understandable by the target group and meets the approval of the instructor
	4. Given the opportunity of working directly with the public	the student will communicate effectively with people through the use of the telephone, in personal conversations and mail correspondence	so well that the content of the communications are clear and accurate
	5. Given records to be filed, magazines and newspapers to be retained	the student will file records and articles and give reasons for filing information in certain sections	so well that needed information can be located when needed and the filing of information meets the approval of the instructor

Occupational Designation: Wastewater Treatment Operator

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
ACQUIRING AND USING GOOD HUMAN RELATION SKILLS WHILE WORKING IN WASTEWATER TREATMENT SYSTEMS	1. Upon completion of pertinent instruction	the student will identify several causes of failures on the job and some of the criteria employers use in advancing or promoting employees	according to given employee handbook
	2. In preparing to enter into an occupation in water and wastewater treatment systems	the student will be capable of explaining verbally or in writing the employee's role, employer's role and the supervisor's role	according to duties of the various groups and to the satisfaction of the instructor

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VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Operator

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
MANAGING AND SUPERVISING EMPLOYEES IN WASTEWATER TREATMENT SYSTEMS	1. Given the opportunity to participate in a simulation exercise prepared by the instructor	the student will demonstrate various recruiting techniques	according to an approved recruiting technique manual
	2. Given the opportunity to participate in a simulation exercise prepared by the instructor	the student will demonstrate the appropriate techniques in controlling absenteeism	so well that the techniques used meet the approval of the instructor
	3. Given the educational background and other measures used in establishing the salaries of two individuals working in the same job classification	the student will verbally explain salary variations and demonstrate appropriate ways in determining adequate salaries for job classifications	with accurate calculations in determining salaries and the explanation meets the approval of the instructor
	4. In a simulated wastewater treatment system exercise prepared by the instructor	the student will arrange work schedules for the required number of employees in the system	so well that the task to be performed can be completed at minimum cost and the work schedule meets the approval of the instructor
	5. In a simulated wastewater treatment exercise prepared by the instructor	the student will manage and supervise employees	so that the task to be performed can be completed in a manner that the employees are satisfied with the supervision and work environment

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CONTROLLING INSECTS AND RODENTS IN WASTEWATER TREATMENT SYSTEM BUILDINGS	1. Using the building facilities in a wastewater treatment system	the student will identify possible areas where insects and rodents are usually located and multiply	to the satisfaction of the instructor and so that that chemical applications can be appropriately applied for controlling the pests
	2. Using insecticides and rodenticide applicators	the student will apply insecticides and rodenticides approved by the U.S. Department of Agriculture	according to manufacturer's directions

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SURVEYING LAND	1. Given an area to be surveyed and access to various types of surveying equipment	the student will select the most appropriate type of survey to be used in surveying the area and give verbal or written reasons for selecting a specific type	so that the area can be accurately surveyed without loss of time and labor and the reasons for selecting a specific type meets the approval of the instructor
	2. Given access to common types of surveying equipment	the student will identify and explain the types, their component parts and their functions	according to the operator's manual
	3. Given access to surveying equipment	the student will transport, carry, set-up, and maintain the equipment	according to the operator's manual
	4. Given access to appropriate surveying equipment and a specified area to be surveyed	the student will perform the following surveying techniques and record field notes a. Basic surveying operations b. Differential leveling c. Profile leveling d. Topographic leveling e. Hand leveling	so well that the area is accurately surveyed and the field notes are accurate and written legibly

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Operator

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED HYDRAULICS IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS	1. Given a specified number of basic terms common in the field of hydraulics,	the student will explain verbally or in writing	95% of the terms according to the appropriate references
	2. Given a specified number of mathematical problems to be solved,	the student will explain and use the principles of pressure to accurately solve	95% of the mathematical problems given which are common to wastewater treatment systems
	3. Given mathematical problems related to flow in pipes and other conduits in wastewater treatment system,	the student will accurately solve	95% of the mathematical problems given
	4. Given mathematical problems related to the flow in open channels in wastewater treatment systems,	the student will accurately solve	95% of the problems given
	5. Given accurate information and mathematical problems related to pumps,	students will accurately calculate	95% of the problems given

LIST OF MODULE TITLES AND PERFORMANCE OBJECTIVES FOR TRAINING WASTEWATER TREATMENT LABORATORY TECHNICIANS

DETERMINING OCCUPATIONAL OPPORTUNITIES AND SECURING EMPLOYMENT IN WASTEWATER TREATMENT SYSTEMS *

USING FIRST AID TECHNIQUES IN A WASTEWATER TREATMENT SYSTEM

USING SAFETY PRACTICES IN THE WASTEWATER TREATMENT LABORATORY

GROOMING ESSENTIALS AND THE USE OF HYGIENIC PRACTICES IN A WASTEWATER TREATMENT LABORATORY

DETERMINING CHARACTERISTICS OF WASTEWATER *

WASHING AND STERILIZING LABORATORY EQUIPMENT

WATER AND WASTEWATER DISEASE TRANSMITTAL *

USING THE MICROSCOPE

USING APPLIED MATHEMATICS IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS *

APPLYING BASIC CHEMISTRY IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS *

USING BASIC BACTERIOLOGY IN WASTEWATER TREATMENT SYSTEMS

PERFORMING VARIOUS LABORATORY TESTS IN THE OPERATION OF WASTEWATER TREATMENT SYSTEMS

ANALYZING AND RECORDING LABORATORY RESULTS

PERFORMING GENERAL OFFICE DUTIES

USING LABORATORY STATISTICS

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* This module can be found in the set of modules under the occupation Wastewater Treatment Operator

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING OCCUPATIONAL OPPORTUNITIES AND SECURING EMPLOYMENT IN WASTEWATER TREATMENT SYSTEMS	1. In seeking information about job opportunities in wastewater treatment systems	the student will conduct personal surveys or obtain literature	that will assist him or her in determining the number and kind of job opportunities which are available in systems where wastewater is treated
	2. Given a specific occupation which the student is interested in	the student will determine the competencies and educational requirements	needed by persons to enter and advance in that career
	3. Upon identifying a job in which the student is interested	the student will follow the proper procedures necessary	to be placed in the job

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Occupational
Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING FIRST AID TECHNIQUES IN A WASTEWATER TREATMENT SYSTEM	1. Given simulated accidents which commonly occur in wastewater treatment systems	the student will demonstrate the proper use of first aid techniques in handling the following problems: a. Body damage due to chemical spills b. Body damage as a result of burns c. Bleeding of the body caused by cuts d. Electrical shocks	according to instructions in given first aid manual
	2. Given simulated accidents which commonly occur in wastewater treatment systems	the student will demonstrate the proper use of first aid techniques in handling the following problems: a. Stopped breathing b. Internal poisoning c. Unconsciousness d. Body fractures	according to instructions in given first aid manual

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT

VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING SAFETY PRACTICES IN THE WASTEWATER TREATMENT LABORATORY	1. While touring or working in a testing laboratory	the student will: a. Verbally identify safety equipment by their common names and explain their uses b. Give verbal reasons why the equipment is located in various areas in the test laboratory	according to the manufacturer's identification of equipment
	2. While touring or working in a testing laboratory	the student will identify and verbally explain safety hazards of the equipment and facilities	according to commonly listed safety hazards as described in wastewater laboratory literature
	3. Given the task of operating fire control equipment in a simulated exercise	the student will select and use the fire control equipment	to control the fire in the simulated exercise prepared by the instructor
	4. Given a simulated accident in the wastewater treatment laboratory	the student will write-up the accident	consistent with the actual occurance

VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
GROOMING ESSENTIALS AND THE USE OF HYGIENIC PRACTICES IN A WASTEWATER TREATMENT LABORATORY	1. While working in a wastewater treatment laboratory	the student will exhibit personal dress and grooming	consistent with available information and based on local norms
	2. While working in a wastewater treatment laboratory	the student should be able to use hygienic practices	which meet or exceed laboratory standards stated in Operation of Wastewater Treatment Plants, by Kenneth Kerri

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VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING CHARACTERISTICS OF WASTEWATER	1. Given various samples of wastewater to be measured	the student will accurately measure the samples for their physical characteristics	95% of the samples should be measured for physical characteristics according to given directions and to the satisfaction of the instructor
	2. Upon completion of receiving pertinent instruction	the student will explain verbally or in writing chemical characteristics of wastewater and their effects	according to information in appropriate reference and to the satisfaction of the instructor
	3. Given access to appropriate equipment, reagents, and samples of wastewater	the student will accurately measure	95% of the samples given for the concentrations of solids, BOD, pH and nitrogen

Occupational
Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
WASHING AND STERILIZING LABORATORY EQUIPMENT	1. Given the task of washing equipment commonly used in a wastewater treatment system laboratory	the student will select and use appropriate cleaning materials in washing given laboratory equipment	without breaking the equipment and in such a way that no foreign particles are visible
	2. Given the responsibility of sterilizing equipment commonly used in a wastewater treatment system laboratory	the student will select and use appropriate sterilizing equipment to sterilize given laboratory equipment	according to directions specified by the manufacturer of the sterilizer

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VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Laboratory Technician

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NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
WATER AND WASTEWATER DISEASE TRANSMITTAL	1. Given the task of explaining several water and wastewater diseases transmitted by air and their effects	students will explain verbally or in writing the given types of diseases and their effects on humans and animals	according to appropriate reference material
	2. Given the task of explaining several water and wastewater diseases transmitted by food, water, solids and their effects	students will explain verbally or in writing the given types of diseases and their effects on humans and animals	according to appropriate reference material
	3. Given the task of explaining several water and wastewater diseases transmitted by insects, animals and their effects	students will explain verbally or in writing the given types of diseases and their effects on humans and animals	according to appropriate reference material

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VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING THE MICROSCOPE	1. Given access to a microscope commonly found in a wastewater treatment system	the student should be able to identify the major parts of the microscope verbally or on a written examination	with 95% accuracy
	2. Given access to a microscope commonly found in wastewater treatment systems	the stude[illegible]hould be able to demonst[illegible]e proper use of the microsco[illegible]	according to directions given in manual

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VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Laboratory Technician

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NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS	1. Given areas to be calculated and materials for making calculations	the students will accurately calculate	95% of the areas given
	2. Given volumes to be calculated and materials for making calculations	the student will accurately calculate	95% of the volumes given
	3. Given the task of calculating velocity and rate of flow	the student will accurately calculate	95% of the velocity and rate of flow mathematical problems given
	4. Given the task of calculating weight relationships	the student will calculate	95% of the weight relationships given
	5. Given accurate information regarding wastewater treatment systems and a given number of efficiency problems to be calculated	the student will accurately calculate	95% of the plant efficiency problems given
	6. Given the task of calculating basic mathematical problems	the student will convert measurements of the English system to the Metric system and calculate	95% of the mathematical problems given
	7. Given accurate information and basic mathematical problems related to wastewater treatment systems	the student will use steps necessary in accurately solving	95% of the mathematical problems given

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VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
APPLYING BASIC CHEMISTRY IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS	1. Given the task of identifying symbols and formulas of chemicals used in wastewater treatment systems,	the student will identify the symbols and formulas with the elements and compounds they represent verbally or in writing	with 95% accuracy
	2. Given equations of chemical reactions used in wastewater treatment systems,	the student will calculate the amounts of reactants needed to produce the desired amounts of products to the correct number of significant figures	as determined by the given data
	3. Given chemical reactions of acids and bases as they relate to the treatment of wastewater	the student will calculate the amounts of acid (base) necessary to neutralize the bases and acids to the correct number of significant figures	as determined by the given concentration of acid (base) and the apparatus appropriate for the determination in wastewater treatment
	4. Given a range of pH to be investigated in an acid base titration	the student will pick an appropriate indicator	as determined by accepted chemical practice

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VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

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Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING BASIC BACTERIOLOGY IN WASTEWATER TREATMENT SYSTEMS	1. Given a combination of positive results in a series of fermentation tube implants	the student will demonstrate the proper use of a table of "most probable numbers" (MPN)	with 95% accuracy
	2. Given access to microbiological materials and equipment and the task of identifying water borne diseases	the student will perform various tests and procedures	to identify all the commonly encountered water borne diseases
	3. Given the appropriate equipment used for performing water quality tests	the student will use the equipment to perform the following tests: a. Multiple tube fermentation test b. A membrane filter test c. Standard plate count	according to local or state water treatment standards

Occupational Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PERFORMING VARIOUS LABORATORY TESTS IN THE OPERATION OF WASTEWATER TREATMENT SYSTEMS	1. Given the task of testing wastewater samples for physical characteristics with access to appropriate apparatus, reagents and procedures	the student will perform the following tests and calculate mathematical problems when necessary: a. Temperature b. Turbidity c. Color d. Dissolved oxygen e. Conductivity f. pH g. Odor	with an accuracy within the accepted limits of good chemical practices
	2. Given the task of testing wastewater samples for organic characteristics with access to appropriate apparatus, reagents and procedures	the student will perform the following tests and calculate mathematical problems when necessary: a. Biochemical Oxygen Demand b. Total Organic Carbon c. Chemical Oxygen Demand d. Total Nitrogen e. Total Phosphorus	with an accuracy within the accepted limits of good chemical practices
	3. Given the task of testing wastewater samples for chemical parameters with access to appropriate apparatus, reagents and procedures	the student will perform the following tests and calculate mathematical problems when necessary: a. Chloride b. Ammonia Nitrogen c. Nitrate Nitrogen d. Sulfate e. Soluble Ortho Phosphates	with an accuracy within the accepted limits of good chemical practices

Occupational Designation: Wastewater Treatment Laboratory Technician

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PERFORMING VARIOUS LABORATORY TESTS IN THE OPERATION OF WASTEWATER TREATMENT SYSTEMS	4. Given the task of testing wastewater samples for bacteriological parameters with access to appropriate apparatus, reagents and procedures	the student will perform the following tests and calculate the mathematical problems when necessary: a. Fecal Coliform b. Fecal Streptococcus	to within acceptable limits as determined by standard bacteriological procedures
	5. Given the responsibility of testing wastewater samples for chemical quality with access to appropriate apparatus, reagents and procedures	the student will perform the following tests and calculate mathematical problems when necessary: a. Chromium b. Copper c. Iron d. Organics e. Sodium f. Zinc g. Total Dissolved Solids	to within plus or minus 0.01 mg accuracy

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VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
ANALYZING AND RECORDING LABORATORY RESULTS	1. Given the task of recording laboratory test results on appropriate forms	the student will record the test results	with 95% accuracy in such a way that they are readable
	2. Given information pertinent to several laboratory tests	the student will analyze and interpret verbally the test results	with 95% accuracy
	3. Given information regarding various laboratory test results	the student will prepare tables, graphs and charts which illustrate trends and changes in the wastewater treatment processes	with 95% accuracy

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT

VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

U.S.O.E. CODE
NUMBER: 01.99

Occupational
Designation: Wastewater Treatment Laboratory Technician

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PERFORMING GENERAL OFFICE DUTIES	1. Given access to a common type of office setting	the student will: a. Answer the telephone b. Clearly converse on the telephone c. Take telephone messages accurately d. Place calls on the telephone e. Prepare and mail a business letter f. File various forms and reports g. Keep the office clean and organized	by following procedures of accepted general office practices

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Wastewater Treatment Laboratory Technician

U.S.O.E. CODE
NUMBER: 01.99

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING LABORATORY STATISTICS	1. Given the task of making measurements and interpreting experiments in a laboratory	the student will understand and use the following statistical terms: a. Arithmetic mean b. Geometric mean c. Standard deviation d. Confidence limits	with an accuracy within the accepted limits of good statistical practices

LIST OF MODULES TITLES AND STUDENT PERFORMANCE OBJECTIVES FOR PREPARING AGRICULTURAL EQUIPMENT MECHANICS

SELECTING, USING AND CARING FOR TOOLS AND EQUIPMENT IN AGRICULTURAL EQUIPMENT MECHANIC SHOPS **

TROUBLESHOOTING THE ENGINES OF FARM TRACTORS

OPERATING OXY-ACETYLENE WELDING EQUIPMENT**

OPERATING ARC WELDING EQUIPMENT**

SERVICING AND REPAIRING ELECTRICAL SYSTEMS IN FARM TRACTORS **

SERVICING AND REPAIRING IGNITION SYSTEMS IN FARM TRACTORS **

SERVICING AND REPAIRING GASOLINE FUEL SYSTEMS ON FARM TRACTORS**

SERVICING AND REPAIRING THE CLUTCH ASSEMBLY IN FARM TRACTORS **

SERVICING AND REPAIRING THE DIFFERENTIAL AND FINAL DRIVE ASSEMBLY IN FARM TRACTORS **

SERVICING AND REPAIRING THE COOLING SYSTEM IN FARM TRACTORS **

SERVICING AND REPAIRING LP-GAS FUEL SYSTEM ON FARM TRACTORS **

SERVICING AND REPAIRING DIESEL FUEL SYSTEMS ON FARM TRACTORS **

INSPECTING AND REPAIRING THE PISTON AND CONNECTING ROD ASSEMBLY IN FARM TRACTORS

DISASSEMBLING AND OVERHAULING THE ENGINE BLOCK AND HEAD IN FARM TRACTORS

SERVICING AND REPAIRING THE STEERING SYSTEM IN FARM TRACTORS

SERVICING AND REPAIRING THE HYDRAULIC SYSTEM IN FARM TRACTORS

SERVICING AND REPAIRING THE BRAKE SYSTEM IN FARM TRACTORS

SERVICING AND REPAIRING THE POWER TAKE-OFF ASSEMBLY IN FARM TRACTORS

SERVICING AND REPAIRING THE AIR CONDITIONING SYSTEMS IN FARM TRACTORS

SERVICING AND REPAIRING TRANSMISSIONS IN FARM TRACTORS **

INSPECTING AND REPAIRING THE CRANKSHAFT AND FLYWHEEL ASSEMBLY IN FARM TRACTORS

REPAIRING THE VALVE SYSTEM IN FARM TRACTORS

SERVICING AND REPAIRING THE GOVERNOR SYSTEM ON FARM TRACTORS

SERVICING AND REPAIRING WHEELS, TIRES, AND TRACKS ON FARM TRACTORS

** Module Completed

LIST OF MODULE TITLES AND STUDENT PERFORMANCE OBJECTIVES FOR PREPARING AGRICULTURAL EQUIPMENT MECHANICS

LUBRICATING AND GREASING FARM TRACTORS

CLEANING AND STORING FARM TRACTORS

ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING FARM TILLAGE EQUIPMENT

ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING FARM PLANTING EQUIPMENT

ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING FARM FERTILIZER APPLICATION EQUIPMENT

ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING SPRAYING AND DUSTING APPLICATION EQUIPMENT

ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING FARM CULTIVATION EQUIPMENT

ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING HARVESTING EQUIPMENT

USING SAFETY AND SANITATION PRACTICES IN AGRICULTURAL EQUIPMENT AND MECHANICS SHOPS

PAINTING AGRICULTURAL EQUIPMENT**

PERFORMING GENERAL OFFICE DUTIES *

USING COMMUNICATION EQUIPMENT

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* This module can be found in the set of modules under the occupation Wastewater Treatment Laboratory Technician

** Module Completed

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Agricultural Equipment Mechanic

U.S.O.E. CODE NUMBER: 01.0301

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING, USING AND CARING FOR TOOLS AND EQUIPMENT IN AGRICULTURAL EQUIPMENT MECHANIC SHOPS	1. Given various types of tool-fittings and cold-metal tools used in repairing agricultural equipment	the student will correctly identify the tools and demonstrate their uses	with 95% of the tools given as presented in a tool catalogue such as published by tool distributing companies and to the satisfaction of the instructor or a person he/she designates
	2. Given various types of machinery maintenance tools used in repairing and servicing agricultural equipment	the student will correctly identify the tools and demonstrate their uses	with 95% of the tools given as presented in a tool catalogue such as published by tool distributing companies and to the satisfaction of the instructor or a person he/she designates
	3. Given various types of equipment used in repairing and servicing agricultural equipment to be cared for and stored	the students will care for and store the equipment	so that the equipment will operate properly when used and is stored to the satisfaction of the instructor or as person he/she designates

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational Designation: Agricultural Equipment Mechanic

U.S.O.E. CODE NUMBER: 01.0301

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
TROUBLESHOOTING THE ENGINES OF FARM TRACTORS	1. Given a farm tractor with defects in the engine and access to tools and equipment	the student will: a. Inspect the engine for defects b. Diagnose the problem c. Correct and adjust for satisfactory operation	according to procedures and directions in service manual and to the satisfaction of the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
OPERATING OXY-ACETYLENE WELDING EQUIPMENT	1. Provided the appropriate oxy-acetylene welding equipment and pieces of steel or cast iron of various thickness	the student will cut steel or cast iron	well enough that the pieces fit intended purpose as determined by the instructor
	2. Given various types of metals to be welded and the appropriate welding equipment	the student will perform butt and fillet welds in various positions that when the following welding processes are completed a. Welding with steel rods b. Bronze welding c. Welding cast iron d. Hardsurfacing e. Fusion welding without a rod	the metals welded will be of sufficient strength for the required operating conditions as determined by the instructor
	3. Given access to gas welding equipment, accessories and various types of metals to be welded or cut	the student will apply safety practices while performing various types of welds or cuttings	which will prevent injury to the body, other workers or damage to the equipment as determined by the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
OPERATING ARC WELDING EQUIPMENT	1. Given a specified number of metals found in agricultural equipment,	the student will identify	95% of the metals by their common names as determined by the instructor or by an individual he/she designates
	2. Given a task of welding two pieces of metal together and the appropriate arc welding equipment	the student will perform the following tasks to produce a weld: a. Prepare the metal for welding b. Select the appropriate electrode c. Select and adjust the proper current setting d. Strike the arc e. Maintain the proper arc length f. Maintain the proper speed of travel g. Run a bead	of sufficient strength for the required operating conditions and satisfaction of the instructor or a person he/she designates
	3. Given a metal to be welded and the appropriate welding equipment	the student will follow safe operating procedures	to prevent injury to himself/herself, other workers or damage to the equipment as determined by the instructor or a person he/she designates
	4. Given metals to be welded and the appropriate welding equipment	the student will prepare the metal and perform butt and fillet	in sufficient strength for the required operating

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OPERATING ARC WELDING EQUIPMENT		welds in the following positions: a. Flat b. Horizontal c. Vertical d. Overhead	conditions and to the satisfaction of the instructor or a person he/she designates
	5. Given various operations to perform with the welder	the student will prepare the metal and perform the following operations: a. Weld cast iron b. Cut and groove c. Hardsurface d. Use the carbon torch	to the satisfaction of the instructor or a person he/she designates

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING ELECTRICAL SYSTEMS IN FARM TRACTORS	1. When provided equipment used to diagnose defects in the electrical system of farm tractors and given a tractor with malfunctions in the starting circuit, lighting and accessory circuits	the student will select and use the equipment in diagnosing the malfunctions in the electrical system	by following approved troubleshooting procedures detailed in appropriate service manual
	2. When provided equipment used to repair the defects in the electrical system of farm tractors with defects in the charging circuit	the student will select and use the equipment to remove, disassemble, test, inspect, replace, reassemble and install the following parts in the charging circuit: a. Generator b. Voltage Regulator c. Alternator (If the engine is so equipped)	according to the procedures in appropriate service manual
	3. When provided equipment used to repair defects in the electrical system of farm tractors and given a farm tractor with malfunctions in the starting circuit	the student will select and use the equipment to remove, disassemble, inspect, test, replace, reassemble, and install the following parts in the starting circuit: a. Starting motor b. Starting switch c. External solenoid	according to the procedures in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING ELECTRICAL SYSTEMS IN FARM TRACTORS	4. When provided equipment used to repair defects in the electrical systems of farm tractors and given a farm tractor with malfunctions in the lighting and/or accessory circuit	the student will select and use the equipment to remove, inspect, service and install the following parts in the lighting and/or accessory circuits: a. Switches b. Fuses c. Wires d. Gauges	according to the procedures in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING IGNITION SYSTEMS IN FARM TRACTORS	1. Given access to a farm tractor with malfunctions in the ignition system and equipment used for checking defects in the system	the student will select and use the equipment in diagnosing the nature of the malfunction	by following the approved troubleshooting procedures detailed in appropriate service manual
	2. Given access to a farm tractor with malfunctions in the ignition system and equipment used for correcting malfunctions in the system	the student will select and use the appropriate equipment to remove, inspect, and test the following components of the system: a. Spark plugs b. Ignition wires c. Distributor d. Coil e. Points and Condenser f. Battery	according to directions in appropriate service manual
	3. Given access to a farm tractor with identified problems in the ignition circuit and equipment used for correcting the problems	the student will select and use the appropriate equipment to replace or service, install and adjust when necessary the following components of the ignition system: a. Spark plugs b. Ignition wires c. Distributor d. Coil e. Points and Condenser f. Battery	according to directions and specifications in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING GASOLINE FUEL SYSTEMS ON FARM TRACTORS	1. Given access to a farm tractor which uses gasoline fuel with observable symptoms in the fuel system and equipment used to diagnose the symptoms in the system	the student will select and use the equipment in diagnosing the nature of the malfunctions in the fuel system	by following appropriate troubleshooting procedures as detailed in appropriate service manual
	2. Given access to a farm tractor which uses gasoline fuel with defects in the fuel system and equipment used to disassemble the system	the student will select and use the equipment to remove, disassemble and inspect the following components of the gasoline fuel system a. Fuel tank b. Fuel Lines c. Air cleaner d. Fuel filter e. Carburetor f. Fuel pump	by following the procedures in appropriate service manual
	3. Given access to a farm tractor which uses gasoline fuel with defects in the system and equipment used to repair the fuel system	the student will use the appropriate equipment to replace, reassemble, install, and adjust the following components to the gasoline fuel system: a. Fuel tank b. Fuel lines c. Air cleaner d. Fuel filter e. Carburetor f. Fuel pump	according to manufacturer's specifications

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING THE CLUTCH ASSEMBLY IN FARM TRACTORS	1. Given access to a farm tractor with defects in the clutch assembly and equipment used for checking defects in the system	the student will select and use the appropriate equipment in diagnosing the nature of the defects	by following the appropriate troubleshooting procedures as detailed in appropriate service manual
	2. Given access to a farm tractor with clutch assembly that has an incorrect amount of free pedal travel, and equipment for adjusting the clutch assembly	the student will select and use the equipment to adjust the clutch linkage and lubricate the clutch release bearing	by following procedures in appropriate service manual
	3. Given access to a farm tractor with defects in the clutch assembly and equipment used to repair the system	the student will select and use the equipment to remove, disassemble, inspect, repair, reassemble and install the following components of the clutch assembly: a. Clutch disk b. Pressure plate c. Pilot bearing and release bearing d. Clutch springs e. Clutch shaft f. Flywheel	according to manufacturer's directions and specifications

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING THE DIFFERENTIAL AND FINAL DRIVE ASSEMBLY IN FARM TRACTORS	1. Given access to a farm tractor with symptoms that indicate malfunctions in the differential and/or final drive assembly and equipment used for checking defects in the two systems	the student will select and use the equipment in diagnosing the nature of the malfunctions in the differential and final drive assembly	by following the procedures described in appropriate service manual
	2. Given access to a farm tractor with differential and final drive assembly, and equipment to service the two systems	the student will select and use the equipment in performing general servicing requirements (e.g. checking and adding oil, flushing rear axle housing)	by following procedures in appropriate service manual
	3. Given access to a farm tractor with defects in the final drive assembly and equipment used for eliminating the problems	the student will select and use the equipment to remove, disassemble, inspect, replace, reassemble, install and adjust the components in the differential	according to instructions in appropriate repair manual
	4. Given access to a farm tractor with defects in the final drive assembly and the equipment used for eliminating the problems	the student will use the equipment to remove, disassemble, inspect, replace, reassemble, install and adjust the components in the final drive assembly	according to instructions in

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING THE COOLING SYSTEM IN FARM TRACTORS	1. Given access to a farm tractor with defects in the cooling system and equipment used to diagnose the defects in the system	the student will select and use the equipment to diagnose the nature of the defects in the cooling system	by following procedures described in appropriate service manual
	2. Given access to a farm tractor with cooling system and equipment used to service the system	the student should be able to select and use the equipment to clean and service the cooling system	by following directions in appropriate service manual and labels on coolant containers used
	3. Given access to a farm tractor with identified defects in the cooling system and equipment used to repair the defects in the system	the student will select and use the equipment to remove, disassemble, inspect, and test the following parts of the cooling system: a. Fan Belt and Fan b. Radiator hoses c. Thermostat d. Radiator e. Water pump f. Water filter	according to procedures in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING THE COOLING SYSTEM IN FARM TRACTORS	4. Given access to a farm tractor with identified defects in the cooling system and equipment to repair the defects in the system	the student will select and use the equipment to replace, reassemble, install and adjust the following parts the cooling system: a. Fan Belt and Fan b. Radiator hoses c. Thermostat d. Radiator e. Water pump f. Water filter	by following the procedures in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING LP-GAS FUEL SYSTEMS ON FARM TRACTORS	1. Given access to a farm tractor which uses LP-Gas fuel and given equipment and materials for testing for leaks in the system	the student will select and use the equipment and materials in testing the LP-Gas fuel system for leaks	by following the procedures described in appropriate service manual
	2. Given access to a farm tractor which uses LP-Gas and with defects in the fuel system, and equipment used to diagnose the symptoms in the system	the student will select and use the equipment for diagnosing the defects in the LP-Gas fuel system	by following appropriate troubleshooting procedures as detailed in appropriate service manual
	3. Given access to a farm tractor which uses LP-Gas fuel and possible defects in the fuel system, with equipment used to remove and disassemble the system	the student will select and use the equipment to remove, disassemble, and inspect the following components of the system: a. Fuel strainer or filter b. Air cleaner c. Carburetor d. Regulator e. Tank	by following procedures in appropriate service manual
	4. Given access to a farm tractor which uses LP-Gas fuel with identified defects in the fuel system, and with equipment used to repair the system	the student should be able to select and use the equipment to reassemble, replace, install and adjust the following components of the system: a. Fuel strainer or filter b. Air cleaner c. Carburetor Regulator Tank	by following the manufacturer's directions and specifications

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING DIESEL FUEL SYSTEMS ON FARM TRACTORS	1. Given access to a farm tractor which uses diesel fuel with defects or problems in the diesel fuel system, and equipment used for checking the problems in the system	the student will select and use the equipment in diagnosing the nature of the malfunctions in the system	by following appropriate troubleshooting procedures as detailed in appropriate service manual
	2. Given access to a farm tractor which uses diesel fuel with air in the fuel system, and the equipment used for bleeding the system	the student will select and use the equipment to bleed the air from the system	by following the procedures outlined in appropriate service manual
	3. When provided a farm tractor which uses diesel fuel with defects or problems in the fuel system, and the equipment used for making repairs	the student will select and use the equipment to remove, disassemble, and inspect the following components of the diesel fuel system: a. Fuel tank b. Fuel pump c. Fuel filter d. Fuel lines e. Injection pump f. Injection nozzles g. Air cleaner	according to the directions in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING DIESEL FUEL SYSTEMS ON FARM TRACTORS	4. Given access to a farm tractor which uses diesel fuel with defects in the fuel system and the equipment used for repairing the system	the student will select and use the equipment to replace, repair, reassemble, install and adjust the following components of the diesel fuel system: a. Fuel tank b. Fuel pump c. Fuel filter d. Fuel lines e. Injection pump f. Injection nozzles g. Air cleaner	according to the instructions in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INSPECTING AND REPAIRING PISTON AND CONNECTING ROD ASSEMBLY IN FARM TRACTORS	1. Given access to a farm tractor with problems or defects in the piston and rod assembly, and equipment used to diagnose the defects	the student will select and use the appropriate equipment to diagnose the nature of the defects	by following trouble-shooting and inspection procedures as described in appropriate service manual
	2. Given access to a farm tractor with defects in the piston and rod assembly and access to tools and equipment	the student will select and use the required equipment to remove and/or disassemble and inspect the following components of the piston and rod assembly for defects: a. Piston b. Piston ring c. Wrist pins d. Connecting rod e. Connecting rod bearings	according to directions and procedures described in appropriate service manual
	3. Given the components of the rod and piston assembly in farm tractors and equipment used for making repairs and servicing	the student will select and use the appropriate equipment to replace, repair, service, reassemble, adjust and install the following components in the rod and piston assembly: a. Piston b. Piston ring c. Wrist pins or piston pins d. Connecting rod e. Connecting rod bearings	by following recommended procedures in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DISASSEMBLING AND OVERHAULING THE ENGINE BLOCK AND HEAD IN FARM TRACTORS	1. Given access to a farm tractor with observable defects in the engine and equipment used to diagnose the defects	the student will select and use the appropriate equipment to diagnose the nature of the following defects: a. Excessive engine knock b. Excessive engine vibration c. Low oil pressure d. Lack of power e. Irregularly running engine f. Difficulty in starting g. Excessive fuel consumption h. Excessive oil consumption i. Excessive engine noise j. Loss of water from overheating	by following approved troubleshooting procedures detailed in appropriate service manual
	2. Given access to a farm tractor, an engine repair stand, and access to tools and equipment	the student will select and use given equipment to drain coolant, remove and mount engine on repair stand	by following steps in appropriate service manual
	3. Given access to a farm tractor engine which has been mounted on a repair stand	the student will select and use given equipment to perform the following tasks: a. Remove cylinder head nuts from block b. Remove cylinder head gaskets and clean surface on head and block	according to procedures in appropriate service manual

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DISASSEMBLING AND OVERHAULING THE ENGINE BLOCK AND HEAD IN FARM TRACTORS		c. Inspect the cylinder head for defects d. Remove the rocker arm assembly	
	4. Given a tractor engine block on a repair stand and access to tools and equipment	the student will perform the following tasks, using appropriate equipment: a. Remove lifting eyes from head b. Compress valve springs and remove locks c. Release springs and remove retainers, springs, rotor and valves d. Place valves in a rack to ensure reassembly in original position e. Inspect valves and seats f. Inspect valve guides g. Inspect valve springs h. Inspect cylinder block and cylinder walls for cracks and other defects i. Measure the cylinder walls for tapering or distortion j. Clean engine block	by following procedures in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DISASSEMBLING AND OVERHAULING THE ENGINE BLOCK AND HEAD IN FARM TRACTORS	5. Given a tractor head and access to equipment	the student will select and use the equipment to perform the following tasks: a. Replace head gaskets b. Install the head c. Torque the engine head	according to specifications in appropriate service manual
	6. Given a tractor engine head and access to equipment	the student will select and use the equipment to perform the following tasks: a. Remove the cylinder ridge when necessary b. Hone the cylinder c. De-glaze cylinder d. Pull cylinder sleeves e. Replace dry and wet sleeves f. Clean the oil passages in the engine block	following procedures in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING THE STEERING SYSTEM IN FARM TRACTORS	1. Given access to a farm tractor with malfunctions in the steering mechanism and equipment used for checking defects in the system	the student will select and use the equipment to diagnose the nature of the malfunctions in the steering system	following approved trouble-shooting procedures as detailed in appropriate service manual
	2. Given access to a farm tractor with defects in the steering system and equipment to repair the defects	the student will select and use the equipment to remove, inspect, disassemble, repair, service, reassemble and install components in the steering system	following direction in appropriate service manual
	3. Given access to a farm tractor with a steering system to be adjusted and the equipment used to make adjustments	the student will select and use the equipment to adjust the alignment and toe-in of the steering system	following the directions in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING THE HYDRAULIC SYSTEM IN FARM TRACTORS	1. Given access to a farm tractor with malfunctions in the hydraulic system and equipment used for checking the defects	the student will select and use the equipment in diagnosing the nature of the malfunctions in the hydraulic system	by following appropriate troubleshooting directions in appropriate service manual
	2. Given access to a farm tractor with hydraulic system and equipment used to service the system	the student will select and use the equipment to service the hydraulic system such as: a. Change filters b. Change and add oil c. Check the system for leaks d. Clean and flush the system	by following the directions and recommendations detailed in appropriate service manual
	3. Given access to a farm tractor with defects in the hydraulic system and equipment used to make repairs	the student will select and use the equipment to remove, disassemble, repair, service, reassemble, install and adjust the following components of the hydraulic system: a. Hydraulic pump b. Hydraulic cylinder c. Hydraulic valves d. Hydraulic filters e. Lines and fittings f. Hydraulic motors g. Hydraulic accumulators h. Hydraulic seals i. Reservoirs, oil coolers, hoses, pipes, tubes and couplers	by following the manufacturer's directions and specifications

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING THE BRAKE SYSTEM IN FARM TRACTORS	1. Given access to a farm tractor with observable defects in the brake system, and equipment used to diagnose the defects	the student will select and use the equipment to diagnose the nature of the defects	by following approved troubleshooting procedures in appropriate service manual
	2. Given access to a farm tractor with a braking system, and equipment used to adjust the brakes	the student will select and use the equipment to adjust the brakes and service the system	by following the procedures in appropriate service manual
	3. Given access to a farm tractor with defects in the brake system, and equipment used to repair the brakes	the student will select and use the equipment to remove, disassemble, inspect, repair, service, reassemble and install the brake system	by following the procedures detailed in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING THE POWER TAKE-OFF ASSEMBLY IN FARM TRACTORS	1. Given access to a farm tractor with observable malfunctions in the power take-off and equipment used for diagnosing defects in the power take-off system	the student will select and use the equipment in diagnosing the nature of the defects in the power take-off system	by following approved procedures in appropriate service manual
	2. Given access to a farm tractor with a power take-off assembly and equipment used to service the system	the student will select and use the equipment to service the power take-off system (such as replacing the safety shields and universal joints)	by following the procedures recommended by the manufacturer
	3. Given access to a farm tractor with identified defects in the power take-off assembly and the drive shaft and equipment used for eliminating the defects in the system	the student will select and use the equipment to remove, disassemble, inspect, service, reassemble, and install the power take-off assembly	by following the procedures in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING THE AIR CONDITIONING SYSTEM ON FARM TRACTORS	1. Given access to a farm tractor with malfunctions in the air conditioning system and equipment used for checking the defects in the system	the student will select and use the equipment in diagnosing the nature of the malfunctions in the air conditioning system	by following the appropriate trouble-shooting procedures detailed in appropriate service manual
	2. Given access to a farm tractor with an air conditioning system and equipment used to service the system	the student will service the air conditioning system by performing such tasks as: a. Check evaporator core for accumulation of dirt and debris and clean if necessary b. Check refrigerant level c. Check compressor drive belt for tightness d. Replace hose protective material and hoses	according to directions in appropriate service manual
	3. Given access to a farm tractor with malfunctions in the air conditioning system and equipment used to replace parts	the student will select and use the equipment to replace the following component parts in the air conditioning system: a. Compressor b. Condensor c. Evaporator d. Circuits and Valves	according to directions in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING TRANSMISSIONS IN FARM TRACTORS	1. Given access to a farm tractor with defects in the transmission system and equipment used to diagnose	the student will select and use the appropriate equipment to diagnose the nature of the defects	according to approved transmission trouble-shooting procedures in appropriate service manual
	2. Given access to a farm tractor transmission system and access to tools and equipment	the student will select and use the equipment to perform the following tasks on the transmission system of a farm tractor: a. Remove the system b. Disassemble the system c. Inspect the system d. Reassemble the system e. Replace parts f. Install the system g. Make adjustments	by following procedures in appropriate service manual
	3. Given a farm tractor and access to equipment and supplies	the student will select and use the appropriate equipment to check and/or change the transmission oil in farm tractors	according to directions and specifications in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INSPECTING AND REPAIRING THE CRANKSHAFT AND FLYWHEEL ASSEMBLY IN FARM TRACTORS	1. When given an engine of a farm tractor with observable symptoms of crankshaft or flywheel problems and equipment used to diagnose the defects	the student will select and use the equipment to diagnose the nature of the defect(s) in the crankshaft and flywheel assembly	by following proper troubleshooting procedures detailed in appropriate service manual
	2. When given an engine of a farm tractor with defects or maladjustments in the crankshaft and flywheel assembly	the student will select and use the appropriate equipment to remove and/or disassemble and inspect the following components for defects: a. Crankshaft b. Main bearings c. Crankshaft timing gear d. Flywheel e. Flywheel ring gear	by following instructions in appropriate repair manual
	3. When given an engine of a farm tractor in which the defects in the crankshaft and flywheel assembly have been identified	the student will select and use appropriate equipment to repair or service, reassemble, install, and adjust the following components of the crankshaft and flywheel assembly: a. Crankshaft b. Main bearings c. Crankshaft timing gear d. Flywheel e. Flywheel ring gear	by following instructions shown in appropriate repair manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
REPAIRING THE VALVE SYSTEMS IN FARM TRACTORS	1. Given access to the engine of a farm tractor with defects in the valve system and the appropriate tools for making repairs	the student will select and use the appropriate tools to perform the following tasks: a. Replace valve guide b. Install valve seat inserts c. Reface valves d. Reface valve seat	by following procedures in appropriate manual
	2. Given access to a farm tractor replacement or repaired valve parts and access to tools and equipment	the student will select and use the desired equipment to perform the following tasks: a. Install intake and exhaust valves b. Install exhaust rotors c. Install springs and retainers d. Install compress valve springs e. Install locks	by following procedures in appropriate service manual
	3. Given the engine of a farm tractor with disassembled parts and access to tools and equipment	the student will select and use desired equipment to perform the following tasks: a. Install head gasket b. Install head assemblies on block c. Install head nuts and tighten	by following the procedures in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
REPAIRING THE VALVE SYSTEMS IN FARM TRACTORS		d. Retighten cylinder head nuts and reset valve clearance after specified hours of operation e. Install injectors and seals in head f. Connect bleed off lines to injectors and high pressure lines between pump and injectors g. Install push rods, rocker arm assemblies, cylinder head covers and breather h. Install intake and exhaust manifolds, water manifold, hoses and thermostat housing i. Connect wire to water temperature gauge sender j. Install engine coolant	

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING THE GOVERNOR SYSTEM ON FARM TRACTORS	1. Given access to a farm tractor with a spark ignition engine which has malfunctions in the governor system and equipment to diagnose the malfunction	the student will select and use the equipment to diagnose the nature of the malfunction	by following procedures detailed in appropriate service manual
	2. Given an engine of a farm tractor with a spark ignition system in which maladjustments have been identified in the governor system and equipment used to make repairs	the student will select and use the equipment to adjust the governor screw or replace the governor spring	according to directions in appropriate service manual
	3. Given an engine of a farm tractor in which defects have been identified in the governor system and equipment used to make repairs	the student will select and use the equipment to perform the following tasks: a. Remove the governor assembly b. Clean the components c. Replace components if necessary d. Reassemble the system e. Install the governor assembly	according to directions in appropriate service manual
	4. Given access to a farm tractor with a diesel engine and defects in the governor assembly and equipment to make adjustments	the student should be able to select and use the equipment to adjust the governor assembly on a diesel engine	by following the recommendations of appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING AND REPAIRING WHEELS, TIRES, AND TRACKS ON FARM TRACTORS	1. Given access to farm tractors with maladjustments in the wheel or track assembly and the equipment to diagnose the problem	the student will select and use desired equipment to diagnose the nature of the problem	by following procedures in appropriate service manual
	2. Given access to a farm tractor with defects in the wheel assembly and equipment to make repairs	the student will select and use appropriate equipment to perform the following tasks: a. Remove the wheel b. Replace or repack wheel bearings c. Replace the seals d. Install and adjust the bearings e. Replace the wheel	according to directions in appropriate service manual
	3. Given access to a farm tractor with defects in the track and idler assembly and equipment used for making repairs	the student will select and use appropriate equipment to perform the following tasks: a. Remove the track b. Remove and replace idler wheels c. Remove and replace track rollers d. Install and adjust the track	according to procedures shown in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
LUBRICATING AND GREASING FARM TRACTORS	1. Given access to a farm tractor in which the oil needs to be changed, the oil filter replaced, and the crankcase breather serviced	the student will select and use the appropriate equipment to perform the following tasks: a. Change crankcase oil b. Replace oil filter c. Service crankcase breather	by following procedures and recommendations in appropriate service manual
	2. Given access to a farm tractor in which the oil pressure gauge, oil pump and other parts in the lubrication system are defective and equipment used to make repairs	the student will select and use the appropriate tools to replace and adjust oil pressure gauges and other parts in the lubrication system	according to directions in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CLEANING AND STORING FARM TRACTORS	1. Given access to a farm tractor which needs to be cleaned and equipment used for cleaning	the student will select and use the equipment to clean the farm tractor	so well that it meets the approval of the instructor
	2. Given a farm tractor and access to tools, equipment and supplies	the student will select and use the tools, equipment and supplies to perform the following tasks before storing the farm tractor: a. Perform engine tune-up b. Drain and refill transmission with fresh oil c. Add corrosion and rust inhibitor to oil d. Clean and repack wheel bearings e. Drain and refill hydraulic system f. Park tractor in selected storage location g. Drain fuel tank h. Remove, clean and replace fuel sediment bowl and filters i. Drain fuel lines and carburetor and seal ends of air inlet pipe, exhaust pipe, crankcase breather pipe, and hydraulic system breather pipe j. Remove and charge battery k. Remove weights from machine and tires	according to directions in appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CLEANING AND STORING FARM TRACTORS		l. Remove tires or raise machine so that tires are off the ground m. Release the tension on all drive belts and chains and apply grease n. Lubricate all points normally requiring lubrication	

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING FARM TILLAGE EQUIPMENT	1. Given the parts to knocked-down farm tillage equipment	the student will inspect the bundles for missing parts and assemble the various types of tillage equipment	according to the directions in appropriate operator's instructional manual
	2. Given tools and the assembled farm tillage equipment	the student will select and use the appropriate tools to make initial adjustments and to service the tillage equipment before using	according to directions in appropriate operator's instructional manual and with 95% accuracy
	3. Given the transportation equipment and the assembled tillage farm equipment	the student will use the equipment in loading, transporting, and unloading the tillage equipment at the proper location	without damaging the equipment
	4. Given the various types of malfunctioning tillage equipment, and access to tools	the student will select and use the tools to service and/or repair tillage equipment	according to directions detailed in appropriate operator's instructional manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
ASSEMBLING, ADJUSTING REPAIRING AND/OR SERVICING FARM PLANTING EQUIPMENT	1. Given the parts to knocked-down farm planting equipment	the student will inspect the bundles for missing parts and assemble the various types of planting equipment	according to the directions in appropriate operator's instructional manual and to the satisfaction of the instructor
	2. Given tools and the assembled farm planting equipment	the student will select and use the appropriate tools to make initial adjustments and service the planting equipment before planting grain crops	according to directions in appropriate operator's instructional manual and with 95% accuracy
	3. Given the transportation equipment and assembled planting equipment	the student will use the equipment in loading, transporting, and unloading the planting equipment at the desired location	without damaging the equipment
	4. Given the types of malfunctioning planting equipment, and access to tools	the student will select and use the tools to service and/or repair planting equipment	according to directions detailed in the operator's instructional manual and with 95% accuracy

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING FARM FERTILIZER APPLICATION EQUIPMENT	1. Given access to knocked-down fertilizer application equipment and the appropriate tools for assembling and adjusting	the student will: a. Inspect the bundles for missing parts and arrange the parts for assembling b. Assemble the fertilizer application equipment c. Adjust the fertilizer application equipment d. Service the fertilizer application equipment before applying fertilizer	according to the directions in appropriate manufacturer's manual and with 100% accuracy and so that the equipment operates safely and efficiently
	2. Given the transportation equipment and the task of transporting and the assembled fertilizer applicator	the student will perform the following tasks with the fertilizer applicator: a. Load b. Transport c. Unload	without damaging the equipment, or injuring people, and within a reasonable time period established by the instructor.
	3. Given access to various types of fertilizer application equipment	the student will perform the following tasks on fertilizer application equipment: a. Service appropriate parts b. Repair damaged or broken parts c. Clean and store	according to directions in appropriate operator's manual so that the equipment continues to operate safely and efficiently

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING OF SPRAYING AND DUSTING APPLICATION FARM EQUIPMENT	1. Given the parts to various types of knocked-down spraying and dusting farm equipment	the student will inspect the bundles for missing parts and assemble the various types of equipment	according to the directions in appropriate operator's instructional manual with 100% accuracy and to the satisfaction of the instructor
	2. Given tools and assembled spraying and dusting farm equipment	the student will select and use the appropriate tools to make initial adjustments and service the equipment before using	according to directions in appropriate operator's instructional manual and to the satisfaction of the instructor with 100% accuracy
	3. Given the vehicles and the assembled spraying and dusting farm equipment	the student will use the vehicles to load, tranpsort, and unload the spraying and dusting farm equipment	without damaging the equipment and to the satisfaction of the instructor with 100% accuracy
	4. Given the tools and various types of malfunctioning farm spray and dusting equipment	the student should be able to select and use the tools to service and/or repair the equipment	according to directions in operator's instructional manual with 100% accuracy

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING FARM CULTIVATION EQUIPMENT	1. Given access to knocked-down farm cultivation equipment and the appropriate tools for assembling and adjusting	the student will: a. Inspect the bundles for missing parts and arrange the parts for assembling b. Assemble the farm cultivati[illegible]ipment c. Adju[illegible] cultivation equipm[illegible]t d. Service the cultivation equipment	according to the directions in appropriate manufacturer's manual so that the equipment operates safely and efficiently
	2. Given the transportation equipment and assembled farm cultivation equipment	the student will perform the following tasks with the cultivation equipment: a. Load b. Transport c. Unload	without damaging the equipment or injuring people, and within a reasonable time period established by the instructor
	3. Given access to various types of farm cultivation equipment	the student will perform the following tasks on the farm cultivation equipment: a. Service appropriate parts b. Repair damaged or broken parts c. Clean and store	according to directions in appropriate operator's manual with 100% accuracy and so that the equipment will operate safely and efficiently

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
ASSEMBLING, ADJUSTING, REPAIRING AND/OR SERVICING HARVESTING FARM EQUIPMENT	1. Given the parts of knocked-down farm harvesting equipment	the student will inspect the bundles for missing parts and assemble the various types of harvesting equipment	according to directions in appropriate operator's instructional manual and to the satisfaction of the instructor
	2. Given tools and assembled harvesting equipment	the student will select and use the appropriate tools to make initial adjustments and service the harvesting equipment before using	according to directions in appropriate operator's instructional manual and to the satisfaction of the instructor
	3. Given the transportation vehicles and the assembled harvesting equipment	the student will use the vehicles in loading, transporting and unloading the harvesting equipment at the desired location	without damaging the equipment
	4. Given the tools and various types of malfunctioning parts in the harvesting equipment	the student will select and use the tools to service and/or repair the harvesting equipment	according to directions detailed in the operator's instructional manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING SAFETY AND SANITATION PRACTICES IN AGRICULTURAL EQUIPMENT MECHANIC SHOPS	1. When working in the school agricultural mechanics facility or on the job	the student will exhibit and follow appropriate personal safety precautions such as: a. Personal dress b. Cleanliness c. Work habits	as established by the instructor or employer
	2. When asked to use various cleaning agents	the student will follow and demonstrate proper safety precautions in using such agents	according to procedures described by the teacher or as detailed on the container of the cleaning agent
	3. Given access to a fork lift and objects to be re-located	the student will follow and demonstrate proper methods of lifting and re-locating objects	according to procedures in fork lift operator's manual, without damaging any objects or the fork lift
	4. Given access to a fire extinguisher and the task of putting out a fire in a simulation exercise prepared by the instructor	the student will demonstrate the proper use of the fire extinguisher in putting out the fire	so well that the fire is completely out, there is no bodily injury or damage to the extinguisher
	5. When working in the Agricultural Mechanic Shop	the student will demonstrate ways in which fires are prevented or controlled with fire extinguishers	to the satisfaction of the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PAINTING AGRICULTURAL EQUIPMENT	1. Given access to agricultural machinery to be cleaned before reconditioning and the equipment used for cleaning	the student will select and use the equipment to clean the agricultural machinery before reconditioning	to the satisfaction of the instructor and by following directions in appropriate operator's manual for equipment used
	2. Given access to cleaned agricultural machinery to be reconditioned and equipment used to sand and prepare the equipment for painting	the student will select and use the equipment to sand and feather-edge machinery for painting	to the satisfaction of the instructor and by following directions of the equipment manufacturer
	3. Given agricultural equipment to be painted	the student will select and mix the paint for application	to the satisfaction of the instructor and by following manufacturer's specifications
	4. Given access to cleaned and sanded agricultural equipment to be primed and mechanical spray painting equipment	the student will safely operate the equipment in applying the primer coat	by following appropriate manufacturer's directions
	5. Given access to mechanical spraying equipment and the task of applying a finish coat(s) to agricultural equipment	the student will properly operate the equipment in applying the finish coat(s) so well	that the finish coat(s) meets the approval of the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PAINTING AGRICULTURAL EQUIPMENT	6. Given the task of touching-up agricultural equipment manually with hand tools	the student will select and use hand tools in touching-up the equipment so well that	the finished product meets the approval of the instructor
	7. Given the task of servicing and cleaning mechanical spraying equipment and cleaning manual tools	the student will select tools and solutions to service and clean mechanical equipment and clean manual equipment so well that	the servicing and cleaning tasks are performed according to manufacturer's directions
	8. Given the task of storing manual and mechanical spraying equipment and other materials used in painting agricultural equipment	the student will organize and store the spraying equipment and materials in a specified area so well	that the storing of the equipment and materials meets the approval of the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PERFORMING GENERAL OFFICE DUTIES	1. Given access to the type of office commonly found in an agricultural equipment repair shop	the student will: a. Answer the telephone b. Clearly converse on the telephone c. Take telephone messages accurately d. Place calls on the telephone e. Prepare and mail a business letter f. File various forms and reports g. Keep the office clean and organized h. Order needed parts for farm machinery	by following procedures of accepted general office practice

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING COMMUNICATION EQUIPMENT	1. Provided a two-way radio	the student will operate the equipment	in accordance to the Federal Communications Commission rules and adjust the squelch and volume to be clearly understood during communications

LIST OF MODULE TITLES AND STUDENT PERFORMANCE OBJECTIVES FOR PREPARING FARM EQUIPMENT OPERATORS

UNDERSTANDING FARM SAFETY AND USING SAFETY PRECAUTIONS IN OPERATING FARM TRACTORS AND EQUIPMENT

SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM TILLAGE EQUIPMENT

SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM FERTILIZER APPLICATION EQUIPMENT

SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM PLANTING EQUIPMENT

SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM CULTIVATION EQUIPMENT

SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM EQUIPMENT USED IN CONTROLLING WEEDS, INSECTS AND OTHER PESTS

SERVICING, STARTING AND DRIVING SELF-PROPELLED COMBINES

OPERATING, ADJUSTING, SERVICING AND STORING SELF-PROPELLED COMBINES

OPERATING FARM TRUCKS IN TRANSPORTING AGRICULTURAL MACHINERY AND COMMODITIES

SELECTING, USING AND CARING FOR TOOLS AND EQUIPMENT IN AGRICULTURAL MECHANIC SHOPS **

SERVICING AND OPERATING HAY AND FORAGE EQUIPMENT

SELECTING AND OPERATING VARIOUS TYPES OF MACHINERY USED FOR HANDLING MATERIALS ON THE FARM

SELECTING AND OPERATING VARIOUS TYPES OF FARM MAINTENANCE EQUIPMENT

PERFORMING GENERAL OFFICE DUTIES *

REPAIRING FARM BUILDINGS ***

USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS ***

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* This module can be found in the set of modules under the occupation Wastewater Treatment Laboratory Technician

** This module can be found in the set of modules under the occupation Agricultural Equipment Mechanic

*** Module not written

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
UNDERSTANDING FARM SAFETY AND USING SAFETY PRECAUTIONS IN OPERATING FARM TRACTORS AND EQUIPMENT	1. Given information regarding the safe operation of farm tractors, self-propelled combines, farm trucks, and other types of farming equipment	the student will perform the following tasks: a. Demonstrate and explain reasons why one should be physically capable of operating farm equipment b. Demonstrate and explain reasons why one should be physiologically capable of operating farm equipment c. Demonstrate and explain reasons why one should be psychologically capable of operating farm equipment d. Explain safety precautions necessary for the safe operation of farm equipment e. Identify and explain various safety driving symbols f. Demonstrate the proper use of hand signals as published by the American Society of Agricultural Engineers (ASAE)	so that when the student is confronted with operating farm equipment, he/she will be proficient in operating the equipment in a safe and efficient manner

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
UNDERSTANDING FARM SAFETY AND USING SAFETY PRECAUTIONS IN OPERATING FARM TRACTORS AND EQUIPMENT	2. Given access to various types of farm tractors (carburetor and diesel) without implement attachments	the student will perform the following tasks: a. Identify and explain the functions of the controls, instruments and other parts on farm tractors b. Check fuel, oil, battery, and radiator if applicable c. Start the engine d. Start the tractor movement forward e. Operate the tractor while in forward motion f. Stop the forward movement of the tractor g. Start, operate and stop the movement of the farm tractor while backing up	so that when the student is given the task of operating the tractor under field conditions, he/she will be capable of operating the equipment in a safe and efficient manner, and to the satisfaction of the instructor or a person designated

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM TILLAGE EQUIPMENT	1. When provided with information regarding the number of acres and type of soil to be prepared for planting	the student will select and operate the appropriate tractor and tillage equipment	so that when the student is confronted with selecting and operating farm tillage equipment, he/she will be proficient in operating the equipment in a safe and efficient manner by following directions in the appropriate operator's manual
	2. Given access to a farm tractor and tillage equipment that has been used in preparing the soil for planting	the student will clean, lubricate and store the tractor and tillage equipment	by following recommendations in given service manuals so that the equipment will operate safely and efficiently when again used to prepare soils for planting

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING, OPERATING, ADJUSTING, SERVICING, AND STORING FARM FERTILIZER APPLICATION EQUIPMENT	1. When provided with information concerning the number of acres and the type of soil to be fertilized	the student will select and operate the appropriate tractor and fertilizer application equipment	so that when the student is confronted with selecting and operating fertilizer application equipment, he/she will be proficient in operating the equipment in a safe and efficient manner by following directions in appropriate operator's manual
	2. Given access to a farm tractor and fertilizer applicator that has been used in applying fertilizer	the student will clean, lubricate and store fertilizer application equipment	by following recommendations in given service manual so that the equipment will operate safely and efficiently when again used to apply fertilizer

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM PLANTING EQUIPMENT	1. When provided with information regarding the number of acres and type of soil to be planted	the student will select and operate the appropriate tractor and planting equipment	so that when the student is confronted with selecting and operating farm planting equipment, he/she will be proficient in operating the equipment in a safe and efficient manner by following directions in the appropriate operator's manual
	2. Given access to a farm tractor and planting equipment to be stored after planting seeds	the student will clean, lubricate and store farm planting equipment	by following recommendations in given service manuals so that the equipment will operate safely and efficiently when again used to plant other types of seeds

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM CULTIVATION EQUIPMENT	1. When provided with information regarding the number of acres and type of soil in which plants are being grown	the student will select and operate the appropriate tractor and cultivation equipment	so that when the student is confronted with selecting and operating farm cultivation equipment, he/she will be proficient in operating the equipment in a safe and efficient manner by following directions in the appropriate operator's manual
	2. Given access to a farm tractor and cultivator which has been used to cultivate grain crops	the student will clean, lubricate, and store the tractor and cultivator equipment	by following recommendations in given service manuals so that the equipment will operate safely and efficiently when again used to cultivate grain crops

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING, OPERATING, ADJUSTING, SERVICING, AND STORING FARM EQUIPMENT USED IN CONTROLLING WEEDS, INSECTS AND OTHER PESTS	1. Given a field (area) on a farm which represents a pest problem	the student will select and operate the appropriate tractor and equipment used for controlling weeds, insects and other pests	so that when the student is confronted with selecting and operating farm equipment used for controlling weeds, insects and other pests, he/she will be proficient in operating the equipment in a safe and efficient manner by following directions in the appropriate operator's manual
	2. Given access to a farm tractor and a chemical applicator which has been used to control pests or weeds	the student will clean, lubricate and store the tractor and chemical applicator	by following recommendations in given service manual so that the equipment will operate safely and efficiently when again used to apply pest chemicals

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SERVICING, STARTING AND DRIVING SELF-PROPELLED COMBINES	1. Given access to a self-propelled combine without harvesting attachments	the student will operate a self-propelled combine without attachments	so that when the student is confronted with operating a self-propelled combine, he/she will be proficient in operating the equipment in a safe manner by following directions in the appropriate operator's manual
	2. Given access to a self-propelled combine with harvesting attachments	the student will operate a self-propelled combine with harvesting attachments	by following recommendations in the appropriate service manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
OPERATING, ADJUSTING, SERVICING AND STORING SELF-PROPELLED COMBINES	1. Given access to a self-propelled combine and the responsibility of harvesting various types of grain crops	the student will operate and adjust a self-propelled combine	so that when the student is confronted with operating and adjusting a self-propelled combine, he/she will be proficient in operating and adjusting the self-propelled combine by following directions in the operator's manual
	2. Given access to a self-propelled combine that has been used to harvest grain crops	the student will lubricate, clean and store the self-propelled combine	by following recommendations in appropriate service manual so that the equipment will operate safely and efficiently when again used to harvest grain crops

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
OPERATING FARM TRUCKS IN TRANSPORTING AGRICULTURAL MACHINERY AND COMMODITIES	1. Given access to various types of farm trucks	the student will service, start and drive a farm truck	so that when the student is given the task of servicing and driving the truck, he/she is capable of doing so by following directions in the appropriate operator's manual
	2. Given access to a farm truck and the responsibility of transporting agricultural equipment to a designated site	the student will hitch equipment to, load, tow and unload farm trucks	without injurying human bodies or damage to farm trucks, machinery, motor vehicles, or other objects

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING, USING AND CARING FOR TOOLS AND EQUIPMENT IN AGRICULTURAL MECHANIC SHOPS	1. Given various types of tool-fittings and cold-metal tools used in repairing agricultural equipment	the student will correctly identify the tools given and demonstrate their uses	95% of the tools given as presented in a tool catalogue such as published by tool distributing companies
	2. Given various types of machinery maintenance tools used in repairing and servicing agricultural equipment	the student will correctly identify the tools and demonstrate their uses	95% of the tools given as presented in a tool catalogue such a published by tool distributing companies
	3. Given various types of equipment used in repairing and/or servicing agricultural equipment to be cared for and stored	the student will care for and store the equipment	so that the equipment will operate properly when used and is stored to the satisfaction of the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING AND OPERATING HAY AND FORAGE EQUIPMENT	1. Given the type of crop and number of acres to be harvested and access to various types of hay and forage equipment	the student will select, attach, operate and adjust hay and forage equipment	as recommended by given operator's manual so that the maximum amount of hay and forage can be harvested
	2. Given access to hay and forage machinery that has been used on the farm	the student will lubricate, clean and store hay and forage equipment	by following recommendations in the appropriate service manuals so that the machinery will operate safely and efficiently when again used to harvest the forage and hay

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING AND OPERATING VARIOUS TYPES OF MACHINERY USED FOR HANDLING MATERIALS ON THE FARM	1. Given the type and quantity of materials to remove from a location on the farm	the student will select, attach, operate and adjust machinery used for handling materials on the farm	as recommended by the appropriate operator's manual and so that farm materials can be removed safely and efficiently
	2. Given access to various types of materials handling machinery that has been used on the farm	the student will lubricate, clean and store materials handling equipment	by following recommedations in the appropriate service manuals so that the machinery will operate safely and effectively when again used to remove materials

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING AND OPERATING VARIOUS TYPES OF FARM MAINTENANCE EQUIPMENT	1. Given the type of farm maintenance task to be performed and access to various types of farm maintenance equipment	the student will select, attach, operate and adjust farm maintenance equipment	as recommended in the appropriate operator's manual and so that the maintenance operation on the farm is performed safely and at maximum efficiency.
	2. Given access to various types of farm maintenance equipment which has been used to make the farm site more productive, safe and attractive	the student will lubricate, clean and store farm maintenance equipment	by following recommendations in the appropriate service manuals so that farm maintenance equipment will operate safely and efficiently when used to maintain the farm site.

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PERFORMING GENERAL OFFICE DUTIES	1. Given access to a common type of office found on the farm	the student will: a. Answer the telephone b. Clearly converse on the telephone c. Take telephone messages accurately d. Place calls on the telephone e. Prepare and mail a business letter f. File various forms and reports g. Keep the office clean and organized	by following procedures of accepted general office practice

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
REPAIRING FARM BUILDINGS	1. Given access to equipment and materials and the responsibility of repairing a farm building	the student will: a. Determine and select the materials (roofing, siding, foundation, etc.) needed for repairing the building b. Repair the foundation by mixing and pouring concrete c. Replace broken windowpanes d. Repair doors and gates and hang them e. Repair wood siding and add braces to farm buildings f. Repair the roof	according to recommendations of construction and materials supply specialists

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	1. Given the appropriate information and the task of calculating agricultural problems relative to lengths	the student will: a. Identify and explain the uses of ten (10) units of lengths used in agriculture b. Convert units of length c. Determine the length of three (3) problems given by the instructor	so that the student will be proficient in calculating various lengths with a degree of accuracy established by the instructor prior to the beginning of the project
	2. Given the required information and the responsibility of calculating agricultural problems pertinent to areas of various shapes	the student will determine the areas for the following shapes: a. Square b. Rectangular c. Triangle d. Trapezoids e. Circle f. Irregular	to the satisfaction of the instructor and so that the student will be efficient in calculating problems on the farm which pertain to areas of various shapes
	3. Given needed information and the task of calculating agricultural volumes of various shapes	the student will determine the volumes for the following shapes: a. Cube b. Rectangle c. Pyramid d. Cylinder e. Cone f. Irregular	according to the accuracy and speed standards set by the instructor in calculating problems on the farm which pertain to the volumes of various shapes

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	4. Given the required information and the task of calculating agricultural problems in regard to weights	the student will: a. Identify and explain the uses of six (6) units of weights used in agriculture b. Convert units of weight c. Select and use scales in weighing agricultural commodities d. Determine weight by multiplying the unit weight times the calculated units in the total volume	so that the student will be proficient in determining the weight of various agricultural commodities with a degree of accuracy established by the instructor prior to the beginning of the project
	5. Given the required information and the task of calculating percentage problems relating to agriculture	the student will: a. List and explain three (3) ways of expressing per cent b. Convert decimals to percent c. Convert fractions to percent d. Explain and demonstrate the proper use of rules to use in solving problems involving percent	so that the student will be capable of determining percentages with a degree of accuracy established by the instructor prior to the beginning of the project
	6. Given the required information and the task of calculating given proportion problems relating to agriculture	the student will: a. Verbally explain ratio expressions three (3) ways b. Solve four (4) proportion problems given by the instructor	so that the student will be proficient in solving problems of proportion with a degree of accuracy established by the instructor prior to the beginning of the project

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	7. Given the required information and the task of calculating interest rates for a loan	the student will: a. Calculate simple interest rate b. Dollar cost c. True interest rate	with 95% accuracy and within a time period specified by the instructor
	8. Given the appropriate information and the task of calculating given depreciation problems	the student will calculate the following types of depreciation problems: a. Straight line b. Declining balance c. Sum of the digits	with 95% accuracy and within a given time period established by the instructor

LIST OF MODULE TITLES AND STUDENT PERFORMANCE OBJECTIVES FOR PREPARING FARM MANAGERS

PLANNING THE CROPPING PROGRAM

DETERMINING FUNCTIONS OF TILLAGE FOR SEED GERMINATION AND PLANT GROWTH

SELECTING A TILLAGE SYSTEM FOR A GRAIN FARMING OPERATION

SELECTING FARM TILLAGE EQUIPMENT

USING THE FARM TRACTOR AND TILLAGE EQUIPMENT TO PREPARE THE SOIL FOR PLANTING GRAIN CROPS

SELECTING FARM PLANTING EQUIPMENT

CALIBRATING FARM PLANTING EQUIPMENT AND PLANTING SEEDS

DETERMINING FERTILITY NEEDS FOR FARM CROPS

SELECTING LIME AND FERTILIZER FOR AGRICULTURAL CROPS

APPLYING FERTILIZER

DETERMINING THE EFFECTS OF FERTILIZER CHEMICALS ON THE ECOLOGY

COMBINING FERTILIZER WITH PESTICIDES AND APPLYING THEM TO FARM GRAIN CROPS

CONTROLLING WEEDS IN GROWING GRAIN CROPS

CONTROLLING INSECTS IN GROWING GRAIN CROPS

CONTROLLING DISEASES IN GROWING GRAIN CROPS

USING THE FARM TRACTOR AND CULTIVATING EQUIPMENT TO CULTIVATE GRAIN CROPS

HARVESTING GRAIN CROPS

DRYING GRAIN CROPS

HANDLING AND STORING GRAIN CROPS

MARKETING GRAIN CROPS

MANAGING AND SUPERVISING EMPLOYEES ON THE FARM

USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS

KEEPING FARM BUSINESS RECORDS

PREPARING FARM BUDGETS

LIST OF MODULE TITLES AND STUDENT PERFORMANCE OBJECTIVES FOR PREPARING FARM MANAGERS

ANALYZING FARM BUSINESS RECORDS

REPLANNING THE FARM BUSINESS FROM RECORD ANALYSIS

FINANCING THE FARM OPERATION

PLANNING FARM POWER, MACHINERY AND EQUIPMENT NEEDS

DETERMINING AND SECURING FARM INSURANCE

FULFILLING FARM TAX RESPONSIBILITIES

INTERPRETING AND UTILIZING FARM LAW

UNDERSTANDING THE FUNCTIONS AND OPERATIONS OF FARMER COOPERATIVES

USING GOVERNMENTAL SERVICES

COMMUNICATIONS IN AGRICULTURE

PERFORMING GENERAL OFFICE DUTIES

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PLANNING THE CROPPING PROGRAM	1. Given various factors that could affect the decision regarding the most suitable cropping program for a given area	the student will explain verbally or in a written examination how the following factors may affect this decision: a. Climatic Conditions b. Soil Conditions c. Governmental programs d. Physical conditions of the farm e. The need for forage and grain in the area f. The yield of crops on farms in the area g. Selection of crop species and varieties suitable to the cropping program of a given farm on the basis of climate, soil and physical farm conditions h. Inputs required for the production of a crop and possible returns	to the satisfaction of the instructor and so that the student is able to determine crop programs best suited for an area
	2. Given the task of preparing a comprehensive plan for a farm cropping program	the student will consider the factors mentioned in student performance objective 1 and plan a comprehensive farm cropping program	so well that in the opinion of a committee of 3 leading farmers in the area, the plan will work satisfactorily for a period of 3-5 years and the rationale for various stages in the plan meets the approval of the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING FUNCTIONS OF TILLAGE FOR SEED GERMINATION AND PLANT GROWTH	1. Given information regarding soil type, soil conditions and crop seed	the student will select the tillage practices that will prepare the soil	for producing 90% or more germination of viable seed planted
	2. Given information relative to soil type and soil conditions	the student will select the tillage practices capable of increasing or decreasing soil compaction and soil moisture, and for producing the most suitable seed bed	based on practices of successful farmers in the community as interpreted by the instructor
	3. When given the probable pests (weeds, insects, diseases, rodents, birds) that may damage a crop	the student will select appropriate tillage practices capable of increasing or decreasing pest problems	according to the current agronomic and pest control information from the Cooperative Extension Service
	4. Given information regarding soil type and conditions and climatic conditions	the student will select the tillage practices capable of reducing erosion in the cash crop farm operations	according to latest soil conservation recommendations

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING A TILLAGE SYSTEM FOR A GRAIN FARMING OPERATION	1. Given specific information regarding the physical properties of soil types and climatic conditions	the student will select a tillage system capable of producing optimum crop yields	according to recommendations of the Cooperative Extension Service
	2. When given information about the size and type of farm implement used in a tillage system	the student will determine the time and costs required to use each system	according to recommendations of the Cooperative Extension Service
	3. When given information pertinent to the implements used and the soil types on which the system were used for various tillage systems	the student will estimate the amount of soil erosion and soil compaction produced by each system	according to recommendations of the Cooperative Extension Service
	4. Given a situation which entails a limited amount of time available due to adverse weather or other factors in performing the planned tillage operations	the student will select alternate tillage practices to provide flexibility in the tillage system	in order to reach the optimum planting dates according to recommendations of the Cooperative Extension Service

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING FARM TILLAGE EQUIPMENT	1. When given information regarding kind and size of tillage implements and the area to be covered	the student will determine the amount of time required per acre for tillage	based on the manufacturer's recommendations and experience of successful farmers in the area
	2. Using information regarding the optimum planting dates for a crop	the student will determine the tillage practices that can be accomplished in the time available under normal weather conditions	according to weather and implement time-use data as verified by the instructor
	3. When provided information regarding the physical properties of the soils	the student will select the kind, size and type of farm tillage equipment needed to adequately prepare the soil for planting	based on recommendations of farm operators of the area as determined by the instructor
	4. Given access to a tillage implement and the task of determining the tractor size needed for maximum efficiency	the student will determine the appropriate size tractor needed	based on recommendations of farm operators of the area as determined by the instructor
	5. Given information regarding the acreage, the size of tillage equipment, size of tractor required, costs and time required to use	the student will calculate the cost of tractor and implement use per acre	based on data compiled from Farm Accounts by Farm Management specialists of the Cooperative Extension Service

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING THE FARM TRACTOR AND TILLAGE EQUIPMENT TO PREPARE THE SOIL FOR PLANTING GRAIN CROPS	1. Given access to a farm tractor with specific tillage equipment and the task of preparing the field for planting grain crops	the student will safely and efficiently operate the farm tractor with the tillage equipment to prepare the soil for planting	according to operator's manual and to the satisfaction of the instructor and/or employer
	2. Given the task of diagnosing malfunctions and making adjustments on farm tillage equipment while in the field	the student will select and use appropriate methods to diagnose and make necessary adjustments on farm tillage equipment	so well that the equipment will operate safely and efficiently
	3. Given the appropriate equipment and the task of preparing farm tillage equipment for storage	the student will select and use the tools to prepare the machinery for storage	by following recommendations in given service manual so that the equipment will operate safely and efficiently when removed from storage

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING FARM PLANTING EQUIPMENT	1. When provided information regarding the kind of crops to be grown and the acreages of each	the student will select the kind and size of planting equipment needed to efficiently perform given task	based on recommendations of successful farmers in the area or recommendations of the Cooperative Extension Service
	2. When provided information regarding the physical properties of the soils and the tillage practices planned	the student will select the type of planting equipment needed	based on recommendations of successful farmers in the area or recommendations of the Cooperative Extension Service
	3. Given information relative to the size and kind of planting equipment and the task of determining the tractor size needed for maximum efficiency	the student will determine the appropriate size tractor needed	based on recommendations of successful farmers in the area or recommendations of the Cooperative Extension Service
	4. Given information regarding area to be covered, size of planting equipment, size of tractor required, costs and time required to use	the student will calculate the cost of tractor and implement use per acre	to the satisfaction of the instructor or employer and with 95% accuracy in the calculations

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CALIBRATING FARM PLANTING EQUIPMENT AND PLANTING SEEDS	1. When provided with farm planting equipment used for planting seeds in rows and the task of making necessary adjustments	the student will adjust the planting equipment when planting seeds of different sizes	in order to attain the correct spacing, depth and rate of seeding per acre. Adjustments of the equipment will be made in line with directions in the operator's manual for the machine
	2. When provided with farm planting equipment used for drilling or broadcasting seeds and the task of making necessary adjustments	the student will adjust the planting equipment when drilling or broadcasting seeds of different sizes	so well that the correct rate of seeding per acre, as recommended by successful farmers of the area, is attained
	3. Given access to a farm tractor with appropriate planting equipment and the task of planting seeds in an area	the student will safely and efficiently operate the planting equipment in planting seeds	according to specifications of the instructor or employer
	4. Given the appropriate tools and the task of preparing farm planting equipment for storage	the student will select and use the tools to prepare the machinery for storage	by following recommendations in given service manual so that the equipment will operate safely and efficiently when needed for planting

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING FERTILITY NEEDS FOR FARM CROPS	1. Given a specified area of soil, appropriate equipment and a specific crop to be grown	the student will perform the following tasks: a. Collect representative soil samples b. Prepare soil samples for testing and submit the samples to the appropriate agency for testing c. Use a soil test report from the soil laboratory, calculate the nutrients available in the soil and determine the amounts and kinds of lime and/or fertilizer needed to achieve maximum returns d. Calculate the cost of acquiring the needed kinds and amounts of lime and fertilizer for a given field	in conformity with recommendations of the local Cooperative Extension personnel, and with 95% accuracy in the mathematical calculations as determined by the instructor
	2. Given the responsibility of determining nutrient deficiency in plants	the student will perform the following: a. Collect plant tissues and submit to the appropriate agency for testing	according to recommendations by the teacher, county agricultural extension agent or personnel of the soil testing laboratory

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING FERTILITY NEEDS FOR FARM CROPS		b. Interpret the results from the plant tissue testing report and recommend the kind and amounts of additional nutrients required to correct the deficiency	
	3. Given the per acre amount (pounds) of crop residue returned to the soil	the student will calculate the nutrients supplied by crop residue	based on recent agronomy data for crop residue fertility with 95% accuracy
	4. Given the appropriate information regarding amount and kind of manure applied to a field	the student will calculate the nutrients supplied to the field	according to published data on livestock waste fertility with 95% accuracy and to
	5. Given information pertinent to the yield goal of a crop to be grown, the amount and kind of nutrients supplied by the soil, manure and crop residue	the student will determine the amount and kind of additional nutrients needed to reach the yield goal	based on crop residue and livestock waste fertility data with 95% accuracy

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING LIME AND FERTILIZER FOR AGRICULTURAL CROPS	1. When given information regarding the chemical compounds of fertilizer materials	the student will convert the oxide pounds to element pounds of nutrients to determine the amount of nutrients supplied	with the degree of accuracy established by the instructor
	2. When given information relative to the fertility needs of a crop above those supplied from the soil, manure and crop residues	the student will determine the amount, grade and ratio of the fertilizer material required	to produce an optimum yield based on the lowest cost per unit of nutrient
	3. Given information pertinent to the sources of lime or fertilizer materials	the student will define the major characteristics of each source in terms of chemical reactions, such as availability, leaching or volatilization, effect on soil pH toxicity to plants, physical form and cost for a crop and soil type	to the satisfaction of the instructor based on agronomic recommendations
	4. When given the appropriate information regarding the amount, grade and ratio of a fertilizer material for production of a specified crop	the student will determine the supply source of the materials	based on convenience, economy and availability with accuracy and completeness

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
APPLYING FERTILIZER	1. Given a list of the crops to be fertilized, the amount, grade and ratio of the fertilizer to be used	the student will: a. Determine the optimum time of year the material should be applied based on seasonal costs of materials and the minimum loss from leaching of nutrients b. Determine method or methods of application to use based on economy and efficiency	according to the recommendations of an agronomy specialist representing the Cooperative Extension Service in the local area
	2. Given access to various types of farm fertilizer application equipment	the student will adjust and safely operate the following types of fertilizer application equipment: a. Row applicator b. Bulk applicator	according to the safety operating procedures in manufacturer's manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING THE EFFECTS OF FERTILIZER CHEMICALS ON THE ECOLOGY	1. Given the plans for fertilizing a field (kind and amount)	the student will: a. Determine the effects on the environment due to soil and water pollution as a result of fertilizer application b. Determine the effects on livestock and man as a result of toxic conditions (systemic) which may occur in plants	in accordance with regulations of the Environmental Protection Agency
	2. Given the appropriate equipment and the task of testing water samples on or near a farm where a variety of fertilizer farm practices are being conducted	the student will select and use the equipment (Hash or Delta Kit) to collect and test water samples for nitrate and nitrite levels	in such a way that the results are 95% accurate.

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
COMBINING FERTILIZER WITH PESTICIDES AND APPLYING THEM TO FARM GRAIN CROPS	1. Given a specific pest problem and fertilizer recommendation for a grain crop	the student will perform the following tasks: a. Select the amount and kind of pesticide and fertilizer materials that are compatible when mixed together and meet the requirements of pest control and nutrient needs b. Determine if the combination of pesticide and fertilizer materials may be hazardous to the environment or applicator	according to recommendations of agronomists and pest control specialist
	2. Given the appropriate materials	the student will perform the following tasks: a. Mix pesticide and fertilizer materials b. Select the appropriate application equipment and make adjustments for chemical application c. Safely operate application equipment and properly store after use	according to the mixing and application requirements of successful farmers of the area and according to the recommendations in the operator's manual for adjusting and for storing the equipment

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CONTROLLING WEEDS IN GROWING GRAIN CROPS	1. Given access to a weedy grain field	the student will outline and recommend an effective biological, cultural and/or chemical weed control program including: a. An explanation as to why weeds should be controlled b. Effect of weeds on crop yields c. Identity of weeds to be controlled d. Explanation as to how weeds spread	to the satisfaction of the instructor and so that when the control practices are implemented the weed problem in the grain field will be resolved
	2. Given the appropriate equipment and the responsibility of controlling weeds in a given area by using various methods of weed control	the student will perform the following tasks in controlling weeds: a. Control weeds by cultural practices b. Control weeds biologically c. Control weeds by using chemicals properly d. Properly store chemicals and the application equipment	so that when the various control practices are performed, the weeds will be controlled, and the equipment and chemicals will be stored to the satisfaction of the instructor.

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CONTROLLING INSECTS IN GROWING FARM GRAIN CROPS	1. Given access to a grain field infested with insects	the student will perform the following tasks: a. Identify the major insects that are attacking the crop by their common name b. Determine the area of damage (roots, leaves, the produced product) c. Determine the insect population and the amount of damage the insect has caused d. Recommend biological and cultural methods of control that are practical to use	so that in the opinion of the instructor when the control practices are carried out, the insect problem in the grain field will be minimized
	2. Given the appropriate equipment	the student will perform the following tasks in controlling insects in grain crops: a. Select and mix insecticides b. Determine right time, proper rate, and correct method of application c. Calibrate equipment d. Safely operate equipment in applying insecticides e. Properly store insecticides and the chemical applicator	so that when the insecticide is applied, in the opinion of the instructor, the insects will be controlled and the remaining chemicals and the applicator are properly stored

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CONROLLING DISEASES IN GROWING GRAIN CROPS	1. Given access to a grain field infested with a disease, and/or specimens or colored photographs of disease	the student will: a. Identify the disease that is affecting the crop by its common name b. Determine the main source of damage (roots, leaves, the produced product) c. Recommend a method of control that is practical to use	so that, in the opinion of the instructor, the identification of the disease(s) and the location of the damage is correct, and when the control practices are carried out the disease problem will have been solved
	2. Given the appropriate equipment and the task of controlling various diseases which affects grain crops	the student will: a. Determine right time, proper rate, and correct method of application of chemicals to control the diseases b. Select and mix chemicals for controlling diseases c. Calibrate equipment d. Safely operate equipment in applying chemicals for controlling diseases e. Properly store chemicals and applicator	so that, in the opinion of the instructor, when the chemical is applied, the disease will be controlled, and the chemicals and equipment will be properly stored

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING THE FARM TRACTOR AND CULTIVATING EQUIPMENT TO CULTIVATE GRAIN CROPS	1. Given access to a farm tractor with specific cultivating equipment	the student will safely and efficiently operate the farm tractor with the cultivating equipment to cultivate the soil	according to the operator's manual and so that the cultivation operation will assist in producing an optimum yield as determined by the instructor
	2. Given the task of diagnosing malfunctions of the tractor and/or cultivating equipment and of making adjustments on farm cultivating equipment while in the field	the student will select and use the appropriate tools to diagnose and make necessary adjustments on the farm equipment	so well that the equipment will operate safely and efficiently
	3. Given the appropriate farm cultivating equipment	the student will prepare the machinery for storage using appropriate tools	by following recommendations in the service manual for the machine so that the equipment will operate safely and efficiently when used to cultivate the soil

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
HARVESTING GRAIN CROPS	1. Given access to various types of grain crops to be harvested	the student will perform the following tasks: a. Determine when to harvest various types of grain crops b. Select the appropriate equipment to be used to carry out the harvesting operations	so that optimum yield in quality and quantity can be obtained
	2. Given access to the appropriate farm equipment and the responsibility of harvesting various types of grain crops	the student will perform the following tasks: a. Prepare the machine for harvesting b. Prepare the field for harvesting, such as plowing the edges of the field for smooth turning and maneuvering c. Make arrangements for transporting the grain from the field to designated site d. Safely operate the harvesting equipment when harvesting grain or transporting the machine from one location to another	so that the harvesting operation is performed efficiently and effectively

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
HARVESTING GRAIN CROPS	3. Given access to farm harvesting equipment and the responsibility of properly storing the equipment	the student will perform the following tasks: a. Lubricate and service various types of harvesting equipment b. Clean various types of harvesting equipment c. Properly store various types of harvesting equipment	so that when the machinery is used for further harvesting, the equipment will operate efficiently and effectively

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DRYING GRAIN CROPS	1. Given access to various types of grain crops to be harvested and dried	the student will: a. Determine the moisture content of the crop in the field within ±2 through visual examination of the crop or by using devices designed to measure moisture content b. Recommend when to harvest the crop c. Recommend the drying equipment and facilities needed for drying grain crops	so that the grain can be dried according to the requirements of the market or for storage, as determined by the instructor
	2. Given the task of drying grain crops with the use of drying facilities and equipment	the student will safely operate and maintain the grain drying facilities to dry grain	according to the operator's manual and the drying need as determined by the instructor or employer

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
HANDLING AND STORING GRAIN CROPS	1. Given access to grain handling facilities and information regarding the type and quantity of grain to relocate	the student will: a. Plan and select the type of materials handling equipment needed for efficient flow and distribution of grain b. Demonstrate the safe operation of the materials handling equipment c. Select and use the appropriate tools to adjust and lubricate the materials handling equipment for maximum efficiency	so that the plan for relocating the grain, and the demonstration of operation and servicing of the equipment is in conformity with the directions in the operator's manual
	2. Given access to grain storage facilities and information pertinent to the type and quantity of grain to be stored	the student will: a. Determine the type and size of facilities needed to provide adequate storage b. Safely operate the materials handling equipment in storing grain in storage facilities c. Determine the amount of grain in storage facilities d. Determine the condition of stored grain e. Select and use the appropriate tools to adjust and lubricate the storing facilities for maximum efficiency	so that in the opinion of the employer, the type and size of storage facilities are adequate, the amount and condition of the grain in storage is accurately recorded, and the operation and servicing of the equipment is in accordance with the operator's manual and the directions of the employer

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
MARKETING GRAIN CROPS	1. Given market reports for current situations as well as reports for the past five-year period	the student will perform the following tasks: a. Determine the price and total return expected by constructing and interpreting supply demand curves b. Determine the cyclic pattern for prices and the most feasible time for marketing the given crop by considering the cyclic pattern and the supply and demand for the particular crop c. Make a recommendation relative to when the product should be marketed	so that the supply/demand curves and the cyclic pattern is accurate within 5% as determined by the instructor and so that the price, on the date the student recommended it be sold is within 15% of estimates of local grain dealers
	2. Given access to farm grain crops to be marketed and to transporting vehicles	the student will perform the following tasks: a. Determine the market grade of the grain according to U.S.D.A. grading standards b. Determine the appropriate method to market the crop by considering services offered, selling costs, competition and return c. Develop a plan for transporting grain to market d. Safely operate materials handling equipment to load	so that the grain to be marketed as determined by the student conforms with the grade assigned by the local dealer, the dealer to whom the student recommends the grain be sold is in agreement with the recommendation of a successful farmer chosen by the instructor, and the grain is loaded and delivered at reasonable cost and with

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
MARKETING FARM GRAIN CROPS		grain on transportation vehicle e. Weigh transportation vehicle and the grain to determine amount of grain to be transported f. Safely operate transportation vehicle in transporting grain to market g. Safely unload grain at market	minimum loss of time or damage, as determined by the farm operator whose grain is being sold

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
MANAGING AND SUPERVISING EMPLOYEES ON THE FARM	1. Given information regarding type and quantity of work to be completed on a given farming operation during a specified time period	the student will: a. Determine the number of employees needed and the abilities required to successfully complete the specified task b. Write a job description and prepare a plan for advertising the position c. Demonstrate the proper procedures for interviewing applicants d. Demonstate the proper procedures in hiring employees	so that: (1) the number of employees needed and list of abilities needed is in conformity with estimates of 2 of 3 successful farm operators in the community; (2) the job description is in conformity with the list of abilities required as determined by the instructor; and (3) the demonstration of interviewing and hiring procedures is acceptable to a committee of farm operators, (or students, or teachers, or businessmen)
	2. Given the responsibility of supervising a group of employees and information relative to the type and quantity of work to be performed on a given type of farming operation during a specified time period	Plan simulated work loads and adequate working conditions for employees; simulate supervision of employees by demonstrating with other students in the class	so that 75% of students agree that the techniques which were demonstrated would be satisfactory under actual conditions

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
MANAGING AND SUPERVISING EMPLOYEES ON THE FARM	3. Given the responsibility of supervising employees in a simulation exercise prepared by the instructor	the student will: a. Evaluate the performance of other students using an appropriate evaluation form provided by the instructor b. Demonstrate the appropriate use of procedures and techniques in releasing employees c. Write a letter of recommendations for employees d. List five (5) items which should be included in farm labor records and explain in writing the reasons for keeping such information	so that students serving as employees in the simulated situation agree (75%) that: (1) the evaluation forms are properly prepared by the supervisor; (2) the techniques used in releasing the employee are acceptable; (3) the letter of recommendation of an employee is accurate and satisfactorily written and the instructor considers the five items required in farm labor records are 100% accurate

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	1. Given the appropriate information and the task of calculating agricultural problems relative to lengths	the student will: a. Identify and explain the uses of ten (10) units of lengths used in agriculture b. Convert units of length c. Determine the length of three (3) problems given by the instructor	so that the student will be proficient in calculating various lengths with a degree of accuracy established by the instructor prior to the beginning of the project
	2. Given the required information and the responsibility of calculating agricultural problems pertinent to areas of various shapes	the student will determine the areas for the following shapes: a. Square b. Rectangular c. Triangle d. Trapezoid e. Circle f. Irregular	to the satisfaction of the instructor and so that the student will be efficient in calculating problems on the farm which pertain to areas of various shapes
	3. Given needed information and the task of calculating agricultural volumes of various shapes	the student will determine the volumes for the following shapes: a. Cube b. Rectangle c. Pyramid d. Cylinder e. Cone f. Irregular	according to the accuracy and speed standards set by the instructor in calculating problems on the farm which pertain to the volumes of various shapes

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	4. Given the required information and the task of calculating agricultural problems in regard to weights	the student will: a. Identify and explain the uses of six (6) units of weights used in agriculture b. Convert units of weight c. Select and use scales in weighing agricultural commodities d. Determine weight by multiplying the unit weight times the calculated units in the total volume	so that the student will be proficient in determining the weight of various agricultural commodities with a degree of accuracy established by the instructor prior to the beginning of the project
	5. Given the required information and the task of calculating percentage problems relating to agriculture	the student will: a. List and explain three (3) ways of expressing per cent b. Convert decimals to percent c. Convert fractions to percent d. Explain and demonstrate the proper use of rules to use in solving problems involving percent	so that the student will be capable of determining percentages with a degree of accuracy established by the instructor prior to the beginning of the project
	6. Given the required information and the task of calculating given proportion problems relating to agriculture	the student will: a. Verbally explain ratio expressions three (3) ways b. Solve four (4) proportion problems given by the instructor	so that the student will be proficient in solving problems of proportion with a degree of accuracy established by the instructor prior to the beginning of the project

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	7. Given the required information and the task of calculating interest rates for a loan	the student will: a. Calculate simple interest rate b. Dollar cost c. True interest rate	with 95% accuracy and within a time period specified by the instructor
	8. Given the appropriate information and the task of calculating given depreciation problems	the student will calculate the following types of depreciation problems: a. Straight line b. Declining balance c. Sum of the digits	with 95% accuracy and within a given time period established by the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
KEEPING FARM BUSINESS RECORDS	1. Given access to a particular farming operation and the past 3 years operating record as well as the appropriate recording forms	the student will: a. List and explain in writing ten (10) reasons why farm records should be kept b. List and explain in writing five (5) types of important records that should be kept in order to provide an accurate financial picture of the farming operation c. Calculate depreciation, correctly enter the results in a farm inventory book and calculate net worth d. Using the cash account book and important records, correctly place and summarize the data in a Farm Cash Account booklet e. Set up Farm Machinery Operation and Maintenance Records f. Correctly enter and summarize the data in the Production Record forms g. Correctly record labor data in Labor Record book	according to directions in given record forms so that when anlayzing the financial situation of the farm, an accurate analysis and interpretation can be made

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PREPARING FARM BUDGETS	1. Given access to records of a specific farming operation, including income and expense items, inventories of soil capability, machinery and equipment, and other data, together with appropriate outlook data from reliable sources (USDA and others)	the student will: a. Correctly set up budget(s) for given enterprise(s) b. Correctly set up a complete trial budget for given farming operation c. Set up a second complete trial budget and determine which budget would be the most profitable d. Accurately work out an operating budget for a specific year showing income and cash expense for each enterprise and the total farm business	according to recommended procedures in record book and with 95% accuracy

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
ANALYZING FARM BUSINESS RECORDS	1. Given access to farm business records and the responsibility of recommending ways for maximizing the farm operation	the student will analyze the farm business including: a. Developing a farm business summary b. Developing a farm business analysis c. Preparing 10 financial statement analysis measures for the farm business d. Prepare written recommendations for improving the efficiency of the farm business	with an arithmetical accuracy of 95% and in 90% conformity with analysis of Farm Management Specialist representing the Cooperative Extension Service in the local area

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
REPLANNING THE FARM BUSINESS FROM RECORD ANALYSIS	1. Given access to the previous 3 year records of a farm business	the student will: a. Set up partial budgets based on his estimates to determine the probable outcome of changes in given farming operation b. Set up an annual operating budget based on recommended changes showing cash income and expenditures for the farm business for the coming year c. Work out a cash flow budget showing estimates of cash income and expenditures, and allowance for income and social security taxes	according to recommended procedures of Farm Management Specialists and with 95% accuracy as determined by the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
FINANCING THE FARMING OPERATION	1. Given access to the financial records of a given farming operation	the student will: a. Prepare an analysis of 3 types of credit which may be appropriate for the farm including sources, costs and estimated returns to the farm business for the use of the credit b. Prepare an operating budget for the farm business c. Prepare an annual operating budget and other planned expenses in the total operation in preparing the cash flow budget	to the satisfaction of the instructor in terms of the recommendations and with 95% accuracy in terms of arithmetical computations
	2. Given the data developed in Objective I and approved by the instructor	the student will prepare applications for a short-term and a long-term loan including for each: a. Evidence of plan for expansion of the business b. Present financial condition of the business c. Proposed repayment schedule	to the satisfaction of the instructor or a representative of a local lending agency

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PLANNING FARM POWER, MACHINERY AND EQUIPMENT NEEDS	1. Given information relative to the type of farming operation and number of acres	the student will prepare recommendations for the machinery and equipment needed on the farm including: a. An inventory of the present machinery and equipment including size of units and their present condition b. Listing of additional needs for farm machinery and equipment to meet present needs and for anticipated needs for 1-5 years in the future. Additional needed items will specify size (capacity) of each machine c. An explanation in writing, justifying the need for each additional piece of equipment, including evidence of the feasibility of the purchase in economic terms d. Recommend a record keeping system for the farm dealing with the purchase and use of farm machinery and equipment on the farm	to the satisfaction of the instructor or an individual he designates

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING AND SECURING FARM INSURANCE	1. Given a specific farm and farm family situation which is typical of the local community, together with insurance reference materials	the student will: a. Explain verbally or in writing the chances of loss, causes of loss and the effect of loss that may occur in a farm business b. Explain verbally or in writing the kinds of life insurance and given examples where each kind is well adapted c. Explain verbally or in writing the types of coverages available through different types of insurance plans (fire, crop, health, etc.) d. List and explain six (6) factors one should consider in selecting an agency from which to purchase insurance	to the satisfaction of the instructor or one or more local insurance executives and/or bankers designated by the instructor
	2. Given the material prepared for Objective I including information about the Farm Operator and the Farm Family	the student will plan the kinds of insurance and the approximate amounts he would recommend for the farm and the family	to the satisfaction of the instructor or one or more local insurance executives and/or bankers designated by the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
FULFILLING FARM TAX RESPONSIBILITIES	1. Given complete annual farm account records for a specific farm and information regarding the farm family and the appropriate forms and instruction books	the student will complete the state income tax report for the farm using the appropriate tax rate schedules and records including necessary supporting data	to the satisfaction of the instructor with 100% accuracy
	2. Given complete annual farm account records for a specific farm and information regarding the farm family and appropriate forms	the student will complete the Federal income tax report for the farm using the appropriate tax rate schedules and records including necessary supporting data	to the satisfaction of the instructor and with 100% accuracy

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INTERPRETING AND UTILIZING FARM LAW	1. Given data on a specific farm operation on which production contracts have been (or may be) written	the student will prepare the data and materials to be submitted to an attorney for use in preparing a production contract for the farm. The materials will include the student's recommendation as to: a. The type of contract b. Provision for termination of the contract c. Provision for single proprietorship, partnership of corporate organization d. Recommendations as to qualification of the attorney who would write the contract e. Provisions in the contract relative to enforceability	to the satisfaction of the instructor or a local attorney designated by the instructor
	2. Given data on a specific farm operation in the local community including farm enterprises, equipment, labor, markets and marketing practices, financial obligations, etc.	the student will prepare written recommendations for the farm operator regarding: a. Major precautions which should be taken in using farm workers b. Landlord-tenant relationships c. Farm operator-employee relationships d. Drainage and water rights and responsibility	to the satisfaction of the instructor or of a legal authority he designates

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INTERPRETING AND UTILIZING FARM LAW		e. Pollution control responsibilities f. Responsibilties for livestock g. Responsibilities regarding livestock diseases h. Responsibilities related to custom work done for others or done for the operator i. Regulations regarding trespassing	

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
UNDERSTANDING THE FUNCTIONS AND OPERATIONS OF FARMER COOPERATIVES	1. Given a group of fellow students or another similar group and appropriate materials on farmer cooperatives	the student will assist the group to organize a real (or simulated) farmer cooperative. In the process of organizing, the student will explain to prospective members: a. The basic principles of cooperative organization b. The advantages (and disadvantages) of cooperative organization for farmers c. The formation of the farmer cooperatives (marketing, supply, service, etc.) d. Financing the cooperative e. Functions and unique problems of managing a farmer cooperative	so that the organization formed by the student group conforms to the standards of the instructor or a farmer cooperative member he designates

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING GOVERNMENTAL SERVICES	1. Given a farm, or a larger agricultural area in the local community together with access to complete files of governmental agencies serving agriculture	the student will list and explain government programs which may be available to: a. Provide services to farmers b. Assist individuals to start farming c. Programs to protect consumers	so that he can present a list of governmental programs for agriculture from which selections may be made for local projects, and a list which is satisfactory to the instructor
	2. Given the data gathered in Objective I together with appropriate governmental forms and instruction book (or other sources)	the student will be able to apply for one or more specified governmental assistance programs for agriculture including: a. Securing the necessary forms and instructional materials b. Completing and submitting the forms	to the satisfaction of the instructor and so that when the student is given the responsibility of obtaining, such services in a real setting, such services can be acquired in an efficient manner

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
COMMUNICATIONS IN AGRICULTURE	1. Given a problem or problem area related to agriculture or farm management	the student will: a. Define a topic for an oral presentation b. Prepare his speech c. Present his speech	to the satisfaction of the instructor or individuals he may designate
	2. Given the responsibility of preparing and presenting a two (2) minute radio spot announcement	the student will: a. Select an appropriate topic b. Prepare the announcement c. Present the spot announcement	according to accepted broadcasting standards and approved by the station manager

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PERFORMING GENERAL OFFICE DUTIES	1. Given access to a common type office found on the farm	the student will: a. Answer the telephone b. Clearly converse on the telephone c. Take telephone messages accurately d. Place calls on the telephone e. Prepare and mail a business letter f. File various forms and reports g. Keep the office clean and organized h. Order needed parts for farm machinery	by following procedures of accepted general office practices

LIST OF MODULE TITLES AND STUDENT PERFORMANCE OBJECTIVES FOR PREPARING FIELD SUPERVISORS

DETERMINING FUNCTIONS OF TILLAGE FOR SEED GERMINATION AND PLANT GROWTH

SELECTING A TILLAGE SYSTEM FOR A GRAIN FARMING OPERATION

SELECTING FARM TILLAGE EQUIPMENT

USING THE FARM TRACTOR AND TILLAGE EQUIPMENT TO PREPARE THE SOIL FOR PLANTING GRAIN CROPS

SELECTING FARM PLANTING EQUIPMENT

CALIBRATING FARM PLANTING EQUIPMENT AND PLANTING SEEDS

DETERMINING FERTILITY NEEDS FOR FARM CROPS

SELECTING LIME AND FERTILIZER FOR AGRICULTURAL CROPS

APPLYING FERTILIZER

COMBINING FERTILIZER WITH PESTICIDES AND APPLYING THEM TO FARM GRAIN CROPS

CONTROLLING WEEDS IN GROWING GRAIN CROPS

CONTROLLING INSECTS IN GROWING GRAIN CROPS

CONTROLLING DISEASES IN GROWING GRAIN CROPS

USING THE FARM TRACTOR AND CULTIVATING EQUIPMENT TO CULTIVATE GRAIN CROPS

HARVESTING GRAIN CROPS

DRYING GRAIN CROPS

HANDLING AND STORING GRAIN CROPS

MARKETING GRAIN CROPS

MANAGING AND SUPERVISING EMPLOYEES ON THE FARM

USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS

KEEPING FARM BUSINESS RECORDS

PREPARING FARM BUDGETS

ANALYZING FARM BUSINESS RECORDS

REPLANNING THE FARM BUSINESS FROM RECORD ANALYSIS

LIST OF MODULE TITLES AND STUDENT PERFORMANCE OBJECTIVES FOR PREPARING FIELD SUPERVISORS

FINANCING THE FARM OPERATION

DETERMINING AND SECURING FARM INSURANCE

FULFILLING FARM TAX RESPONSIBILITIES

INTERPRETING AND UTILIZING FARM LAW

UNDERSTANDING THE FUNCTIONS AND OPERATIONS OF FARMER COOPERATIVES

USING GOVERNMENTAL SERVICES

COMMUNICATIONS IN AGRICULTURE

PERFORMING GENERAL OFFICE DUTIES

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING FUNCTIONS OF TILLAGE FOR SEED GERMINATION AND PLANT GROWTH	1. Given information regarding soil type, soil conditions and crop seed	the student will select the tillage practices that will prepare the soil	for producing 90% or more germination of viable seed planted
	2. Given information relative to soil type and soil conditions	the student will select the tillage practices capable of increasing or decreasing soil compaction and soil moisture, and for producing the most suitable seed bed	based on practices of successful farmers in the community as interpreted by the instructor
	3. When given the probable pests (weeds, insects, diseases, rodents, birds) that may damage a crop	the student will select appropriate tillage practices capable of increasing or decreasing pest problems	according to the current agronomic and pest control information from the Cooperative Extension Service
	4. Given information regarding soil type and condition and climatic conditions	the student will select the tillage practices capable of reducing erosion in the cash crop farm operations	according to latest soil conservation recommendations

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING A TILLAGE SYSTEM FOR A GRAIN FARMING OPERATION	1. Given specific information regarding the physical properties of soil types and climatic conditions	the student will select a tillage system capable of producing optimum crop yields	according to recommendations of the Cooperative Extension Service
	2. When given information about the size and type of farm implement used in a tillage system	the student will estimate the amount of soil erosion and soil compaction produced by each system	according to recommendations of the Cooperative Extension Service
	3. When given information pertinent to the implements used and the soil types on which the system was used for various tillage systems	the student will estimate the amount of soil erosion and soil compaction produced by each system	according to recommendations of the Cooperative Extension Service
	4. Given a situation which entails a limited amount of time available due to adverse weather or other factors in performing the planned tillage operations	the student will select alternate tillage practices to provide flexibility in the tillage system	in order to reach the optimum planting dates according to recommendations of the Cooperative Extension Service

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING FARM TILLAGE EQUIPMENT	1. When given information regarding kind and size of tillage implements and the area to be covered	the student will determine the amount of time required per acre for tillage	based on the manufacturer's recommendations and experience of successful farmers in the area
	2. Using information regarding the optimum planting dates for a crop	the student will determine the tillage practices that can be accomplished in the time available under normal weather conditions	according to weather and implement time-use data as verified by the instructor
	3. When provided information regarding the physical properties of the soils	the student will: a. select the kind, size and type of farm tillage equipment needed to adequately prepare the soil for planting b. Explain to all workers the reason for selecting the tillage equipment	based on recommendations of farm operators of the area as determined by the instructor
	4. Given access to a tillage implement and the task of determining the tractor size needed for maximum efficiency	the student will: a. determine the appropriate size tractor needed b. Explain to other workers how to determine the size tractor needed for performing a given task	based on recommendations of farm operators of the area as determined by the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING FARM TILLAGE EQUIPMENT	5. Given information regarding the acreage, the size of tillage equipment, size of tractor required, costs and time required to use	the student will calculate the cost of tractor and implement use per acre	based on data compiled from Farm Accounts by Farm Management specialists of the Cooperative Extension Service

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING THE FARM TRACTOR AND TILLAGE EQUIPMENT TO PREPARE THE SOIL FOR PLANTING GRAIN CROPS	1. Given access to a farm tractor with specific tillage equipment and the task of preparing the field for planting grain crops	the student will: a. safely and efficiently operate the farm tractor with the tillage equipment to prepare the soil for planting b. demonstrate to other workers how to safely operate the farm tractor and tillage equipment	according to operator's manual
	2. Given the task of diagnosing malfunctions and making adjustments on farm tillage equipment while in the field	the student will: a. select and use appropriate methods to diagnose and make necessary adjustments on farm tillage equipment b. supervise other workers in making necessary adjustments on the farm tillage equipment	so well that the equipment will operate safely and efficiently
	3. Given the appropriate equipment and the task of preparing farm tillage equipment for storage	the student will: a. select and use the tools to prepare the machinery for storage b. supervise other workers in preparing the machinery for storage	by following recommendations in given service manual so that the equipment will operate safely and efficiently when removed from storage

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING FARM PLANTING EQUIPMENT	1. When provided information regarding the kind of crops to be grown and the acreages of each	the student will determine the kind and size of planting equipment needed to efficiently perform given task	based on recommendations of successful farmers in the area or recommendations of the Cooperative Extension Service
	2. When provided information regarding the physical properties of the soils and the tillage practices planned	the student will select the type of planting equipment needed	based on recommendations of successful farmers in the area or recommendations of the Cooperative Extension Service
	3. Given information relative to the size and kind of planting equipment and the task of determining the tractor size needed for maximum efficiency	the student will: a. Determine the appropriate size tractor needed b. Explain to other workers the factors used to determine appropriate size tractor	based on recommendations of successful farmers in the area or recommendations of the Cooperative Extension Service
	4. Given information regarding area to be covered, size of planting equipment, size of tractor required, costs and time required to use	the student will calculate the cost of tractor and implement use per acre	to the satisfaction of the instructor or employer and with 95% accuracy in the calculations

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CALIBRATING FARM PLANTING EQUIPMENT AND PLANTING SEEDS	1. When provided with farm planting equipment used for planting seeds in rows and the task of making necessary adjustments	the student will: a. adjust the planting equipment when planting seeds of different sizes b. supervise other workers in adjusting the planting equipment	in order to attain the correct spacing, depth and rate of seeding per acre. Adjustments of the equipment will be made in line with directions in the operator's manual for the machine
	2. When provided with farm planting equipment used for drilling or broadcasting seeds and the task of making necessary adjustment	the student will adjust the planting equipment when drilling or broadcasting seeds of different sizes and supervise other workers in performing these tasks	so well that the correct rate of seeding per acre, as recommended by successful farmers of the area, is attained
	3. Given access to a farm tractor with appropriate planting equipment and the task of planting seeds in an area	the student will: a. safely and efficiently operate the planting equipment in planting seeds b. supervise other workers in operating the planting equipment	according to specifications of the instructor or employer
	4. Given the appropriate tools and the task of preparing farm planting equipment for storage	the student will: a. select and use the tools to prepare the machinery for storage b. supervise other workers in selecting and using tools to prepare the machinery for storage	by following recommendations in given service manual so that the equipment will operate safely and efficiently when needed for planting

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING FERTILITY NEEDS FOR FARM CROPS	1. Given a specified area of soil, appropriate equipment and a specific crop to be grown	the student will perform the following tasks: a. Collect representative Soil samples b. Prepare soil samples for testing and submit the samples to the appropriate agency for testing c. Use a soil test report from the soil laboratory, calculate the nutrients available in the soil and determine the amounts and kinds of lime and/or fertilizer needed to achieve maximum returns d. Calculate the cost of acquiring the needed kinds and amounts of lime and fertilizer for a given field	in conformity with recommendations of the local Cooperative Extension personnel, and with 95% accuracy in the mathematical claculations as determined by the instructor
	2. Given the responsibility of determining nutrient deficiency in plants	the student will perform the following: a. Collect plant tissues and submit to the appropriate agency for testing	according to recommendations by the teacher, county agricultural extension agent or personnel of the soil testing laboratory

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING FERTILITY NEEDS FOR FARM CROPS		b. Interpret the results from the plant tissue testing report and recommend the kind and amounts of additional nutrients required to correct the deficiency	
	3. Given the per acre amount (pounds) of crop residue returned to the soil	the student will calculate the nutrients supplied by crop residue	based on recent agronomy data for crop residue fertility with 95% accuracy
	4. Given the appropriate information regarding amount and kind of manure applied to a field	the student will calculate the nutrients supplied to the field	according to published data on livestock waste fertility with 95% accuracy
	5. Given information pertinent to the yield goal of a crop to be grown, the amount and kind of nutrients supplied by the soil, manure and crop residue	the student will determine the amount and kind of additional nutrients needed to reach the yield goal	based on crop residue and livestock waste fertility data with 95% accuracy

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SELECTING LIME AND FERTILIZER FOR AGRICULTURAL CROPS	1. When given information regarding the chemical compounds of fertilizer materials	the student will convert the oxide pounds to element pounds of nutrients to determine the amount of nutrients supplied	with the degree of accuracy established by the instructor
	2. When given information relative to the fertility needs of a crop above those supplied from the soil, manure and crop residues	the student will determine the amount, grade and ratio of the fertilizer material required	to produce an optimum yield based on the lowest cost per unit of nutrient
	3. Given information pertinent to the sources of lime or fertilizer materials	the student will define the major characteristics of each source in terms of chemical reactions, such as availability, leaching or pH toxicity to plants, physical form and cost for a crop and soil type	to the satisfaction of the instructor and based on agronomic recommendations
	4. When given the appropriate information regarding the amount, grade and ratio of a fertilizer material for production of a specified crop	the student will determine the supply source of the materials	based on convenience, economy and availabilty with accuracy and completeness

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
APPLYING FERTILIZER	1. Given a list of the crops to be fertilized, the amount, grade and ratio of the fertilizer to be used	the student will: a. determine the optimum time of year the material should be applied based on seasonal costs of materials and the minimum loss from leaching of nutrients b. determine method or methods of application to use based on economy and efficiency	according to the recommendations of an agronomy specialist representing the Cooperative Extension Service in the local area
	2. Given access to various types of farm fertilizer application equipment	the student will supervise other workers in adjusting and operating the following types of fertilizer application equipment: a. row applicator b. bulk applicator	according to the safety operating procedures in manufacturer's manual

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
COMBINING FERTILIZER WITH PESTICIDES AND APPLYING THEM TO FARM GRAIN CROPS	1. Given a specific pest problem and fertilizer recommendation for a grain crop	the student will perform the following tasks: a. Select the amount and kind of pesticide and fertilizer materials that are compatible when mixed together and meet the requirements of pest control and nutrient needs b. Determine if the combination of pesticide and fertilizer materials may be hazardous to the environment or applicator	according to recommendations of agronomists and pest control specialist
	2. Given the appropriate materials	the student will perform the following tasks: a. Supervise other workers in mixing pesticide and fertilizer materials b. Supervise other workers in selecting the appropriate application equipment and make adjustments for chemical application c. Supervise other workers in operating application equipment and properly store after use	according to the mixing and application requirements of successful farmers of the area and according to the recommendations in the operator's manual for adjusting and for storing the equipment

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CONTROLLING WEEDS IN GROWING GRAIN CROPS	1. Given access to a weedy grain field	the student will outline and recommend an effective biological, cultural and/or chemical weed control program including: a. An explanation as to why weeds should be controlled b. Effect of weeds on crop yields c. Identity of weeds to be contolled d. Explanation as to how weeds spread	to the satisfaction of the instructor and so that when the control practices are implemented the weed problem in the grain field will be resolved
	2. Given the appropriate equipment and the responsibility of controlling weeds in a given area by using various methods of weed control	the student will perform the following tasks in controlling weeds: a. Supervise other workers in controlling weeds by cultural practices b. Supervise other workers in controlling weeds biologically c. Supervise other workers in controlling weeds by using chemicals properly d. Supervise other workers in properly storing chemicals and the application equipment	so that when the various control practices are performed, the weeds will be controlled and the equipment and chemicals will be stored to the satisfaction of the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CONTROLLING INSECTS IN GROWING FARM GRAIN CROPS	1. Given access to a grain field infested with insects	the student will perform the following tasks: a. Identify the major insects that are attacking the crop by their common name b. Determine the area of damage (roots, leaves, the produced product) c. Determine the insect population and the amount of damage the insect has caused d. Recommend biological and cultural methods of control that are practical to use	so that in the opinion of the instructor when the control practices are carried out, the insect problem in the grain field will be minimized
	2. Given the appropriate equipment	the student will perform the following tasks in controlling insects in grain crops: a. Supervise other workers in selecting and mixing insecticides b. Supervise other workers in determining right time, proper rate, and correct method of application c. Supervise other workers in calibrating equipment d. Supervise other workers in safely operating equipment in applying insecticides	so that when the insecticide is applied, in the opinion of the instructor, the insects will be controlled and the remaining chemicals and the applicator are properly stored

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CONTROLLING INSECTS IN GROWING FARM GRAIN CROPS		e. Supervise other workers in properly storing insecticides and the chemical applicator	

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
CONTROLLING DISEASES IN GROWING GRAIN CROPS	1. Given access to a grain field infested with a disease, and/or specimens of colored photographs of disease	the student will: a. Identify the disease that is affecting the crop by its common name b. Determine the main source of damage (roots, leaves, the produced product) c. Recommend a method of control that is practical to use	so that, in the opinion of the instructor, the identification of the disease(s) and the location of the damage is correct, and when the control practices are carried out the disease problem will have been solved
	2. Given the appropriate equipment and the task of controlling various disease which affects grain crops	the student will: a. Determine right time, proper rate, and correct method of application of chemicals to control the disease b. Supervise other workers in selecting and mixing chemicals for controlling diseases c. Supervise other workers in calibrating equipment d. Supervisor other workers in safely operating equipment in applying chemicals for controlling diseases e. Supervise other workers in properly storing chemicals and applicator	so that, in the opinion of the instructor, when the chemical is applied, the disease will be controlled, and the chemicals and equipment will be properly stored

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING THE FARM TRACTOR AND CULTIVATING EQUIPMENT TO CULTIVATE GRAIN CROPS	1. Given access to a farm tractor with specific cultivating equipment	the student will safely and efficiently supervise other workers in operating the farm tractor with cultivating equipment to cultivate the soil	according to the operator's manual and so that the cultivation operation will assist in producing an optimum yield as determined by the instructor
	2. Given the task of assisting other workers in diagnosing malfunctions of the tractor and/or cultivating equipment and of making adjustments on farm cultivating equipment while in the field	the student will supervise other workers in appropriate tools to diagnose and make necessary adjustments on farm equipment	so well that the equipment will operate safely and efficiently
	3. Given access to farm cultivating equipment	the student will supervise other workers in preparing the machinery for storage using appropriate tools	by following recommendations in the service manual for the machine so that the equipment will operate safely and efficiently when used to cultivate the soil

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
HARVESTING GRAIN CROPS	1. Given access to various types of grain crops to be harvested	the student will perform the following tasks: a. Determine when to harvest various types of grain crops b. Select the appropriate equipment to be used to carry out the harvesting operations and explain to other workers the reason for selection	so that optimum yield in quality and quantity can be obtained
	2. Given access to the appropriate farm equipment and the responsibility of harvesting various types of grain crops	the student will perform the following tasks: a. Supervise other workers in preparing the machine for harvesting b. Supervise other workers in preparing the field for harvesting, such as plowing the edges of the field for smooth turning and maneuvering c. Make arrangements for transporting the grain from the field to designated site d. Supervise the workers in safely operating the harvesting equipment when harvesting grain or transporting the machine from one location to another	so that the harvesting operation is performed efficiently and effectively

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
HARVESTING GRAIN CROPS	3. Given access to farm harvesting equipment and the responsibility of properly storing the equipment	the student will perform the following tasks: a. Supervise other workers in lubricating and servicing various types of harvesting equipment b. Supervise other workers in cleaning various types of harvesting equipment c. Supervise other workers in properly storing various types of harvesting equipment	so that when the machinery is used for further harvesting, the equipment will operate efficiently and effectively

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DRYING GRAIN CROPS	1. Given access to various types of grain crops to be harvested and dried	the student will: a. Determine the mositure content of the crop in the field within ±2 through visual examination of the crop or by using devices designed to measure moisture content b. Recommend when to harvest the crop c. Recommend the drying equipment and facilities needed for drying grain crops	so that the grain can be dried according to the requirements of the market or for storage, as determined by the instructor
	2. Given the task of drying grain crops with the use of drying facilities and equipment	the student will supervise other workers in operating and maintaining the grain drying facilities to dry grain	according to the operator's manual and the drying need as determined by the instructor or employer

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
HANDLING AND STORING GRAIN CROPS	1. Given access to grain handling facilities and information regarding the type and quantity of grain to relocate	the student will: a. Plan and select the type of materials handling equipment needed for efficient flow and distribution of grain b. Supervise other workers in operating the materials handling equipment c. Supervise other workers in selecting and using the appropriate tools to adjust and lubricate the materials handling equipment for maximum efficiency	so that the plan for relocating the grain, and the operation and servicing of the equipment is in conformity with the directions in the operator's manual and
	2. Given access to grain storage facilities and information pertinent to the type and quantity of grain to be stored	the student will: a. Determine the type and size of facilities needed to provide adequate storage b. Supervise other workers in operating the materials handling equipment c. Supervise other workers in determining the amount of grain in storage facilities d. Supervise other workers in determining the condition of stored grain	so that in the opinion of the employer, the type and size of storage facilities are adequate, the amount and condition of the grain in storage is accurately recorded, and the operation and servicing of the equipment is in accordance with the operator's manual and the direction's of the employer

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HANDLING AND STORING GRAIN CROPS		e. Supervise other workers in selecting and using the appropriate tools to adjust and lubricate the storing facilities for maximum efficiency	

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
MARKETING GRAIN CROPS	1. Given market reports for current situations as well as reports for the past five-year period	the student will perform the following tasks: a. Determine the price and total return expected by constructing and interpreting supply demand curves b. Determine the cyclic pattern for prices and the most feasible time for marketing the given crop by considering the cyclic pattern and the supply and demand for the particular crop c. Make a recommendation relative to when the product should be marketed	so that the supply/demand curves and the cyclic pattern is accurate within 5% as determined by the instructor and so that the price, on the date the student recommended it be sold is within 15% of estimates of local grain dealers by
	2. Given access to farm grain crops to be marketed and to transporting vehicles	the student will perform the following tasks: a. Determine the market grade of the grain according to U.S.D.A. grading standards b. Determine the appropriate method to market the crop by considering services offered, selling costs, competition and return c. Develop a plan for transporting grain to market	so that the grain to be marketed as determined by the student conforms with the grade assigned by the local dealer, the dealer to whom the student recommends the grain be sold is in agreement with the recommendation of a successful farmer chosen by the instructor, and the grain is loaded and delivered at reasonable cost and with

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MARKETING GRAIN CROPS		d. Safely operate materials handling equipment to load grain on transportation vehicle e. Weigh transportation vehicle and the grain to determine amount of grain to be transported f. Safely operate transportation vehicle in transporting grain to market g. Safely unload grain at market	minimum loss of time or damage, as determined by the farm operator whose grain is being sold

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
MANAGING AND SUPERVISING EMPLOYEES ON THE FARM	1. Given information regarding type and quantity of work to be completed on a given farming operation during a specified time period	the student will: a. Determine the number of employees needed and the abilities required to successfully complete the specified task b. Write a job description and prepare a plan for advertising the position c. Demonstrate the proper procedures for interviewing applicants d. Demonstrate the proper procedures in hiring employees	so that: (1) the number of employees needed and list of abilities needed is in conformity with estimates of 2 of 3 successful farm operators in the community; (2) the job description is in conformity with the list of abilities required as determined by the instructor; and (3) the demonstration of interviewing and hiring procedures is acceptable to a committee of farm operators, (or students, or teachers, or businessmen)
	2. Given the responsibility of supervising a group of employees and information relative to the type and quantity of work to be performed on a given type of farming operation during a specified time period	plan simulated work loads and adequate working conditions for employees; simulate supervision of employees by demonstrating with other students in the class	so that 75% of students agree that the techniques which were demonstrated would be satisfactory under actual conditions

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MANAGING AND SUPERVISING EMPLOYEES ON THE FARM	3. Given the responsibility of supervising employees in a simulation exercise prepared by the instructor	the student will: a. Evaluate the performance of other students using an appropriate evaluation f[illegible]rovided by the [illegible]ctor b. Demonstrate the appropriate use of procedures and techniques in releasing employees c. Write a letter of recommendation for an employee d. List five (5) items which should be included in farm labor records and explain in writing the reasons for keeping such information	so that students serving as employees in the simulated situation agree (75%) that: (1) the evaluation forms are properly prepared by the supervisor; (2) the techniques used in releasing the employee are acceptable; (3) the letter of recommendation of an employee is accurate and satisfactorily written and the instructor considers the five items required in farm labor records are 100% accurate

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	1. Given the appropriate information and the task of calculating agricultural problems relative to lengths	the student will: a. Identify and explain the uses of ten (10) units of lengths used in agriculture b. Convert units of length c. Determine the length of three (3) problems given by the instructor	so that the student will be proficient in calculating various lengths with a degree of accuracy established by the instructor prior to the beginning of the project
	2. Given the required information and the responsibility of calculating agricultural problems pertinent to areas of various shapes	the student will determine the areas for the following shapes: a. Square b. Rectangular c. Triangle d. Trapezoid e. Circle f. Irregular	to the satisfaction of the instructor and so that the student will be efficient in calculating problems on the farm which pertain to areas of various shapes
	3. Given needed information and the task of calculating agricultural volumes of various shapes	the student will determine the volumes for the following shapes: a. Cube b. Rectangle c. Pyramid d. Cylinder e. Cone f. Irregular	according to the accuracy and speed standards set by the instructor in calculating problems on the farm which pertain to the volumes of various shapes

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USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	4. Given the required information and the task of calculating agricultural problems in regard to weights	the student will: a. Identify and explain the uses of six (6) units of weights used in agriculture b. Convert units of weight c. Select and use scales in weighing agricultural commodities d. Determine weight by multiplying the unit weight times the calculated units in the total volume	so that the student will be proficient in determining the weight of variou agricultural commodities with a degree of accuracy established by the instructor prior to the beginning of the project
	5. Given the required information and the task of calculating percentage problems relating to agriculture	the student will: a. List and explain three (3) ways of expressing per cent b. Convert decimals to percent c. Convert fractions to percent d. Explain and demonstrate the proper use of rules to use in solving problems involving percent	so that the student will be capable of determining percentages with a degree of accuracy established by the instructor prior to the beginning of the project
	6. Given the required information and the task of calculating given proportion problems relating to agriculture	the student will: a. Verbally explain ratio expressions three (3) ways b. Solve four (4) proportion problems given by the instructor	so that the student will be proficient in solving problems of proportion with a degree of accuracy established by the instructor prior to the beginning of the project

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USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	7. Given the required information and the task of calculating interest rates for a loan	the student will: a. Calculate simple interest rate b. Dollar cost c. True interest rate	with 95% accuracy and within a time period specified by the instructor
	8. Given the appropriate information and the task of calculating given depreciation problems	the student will calculate the following types of depreciation problems: a. Straight line b. Declining balance c. Sum of the digits	with 95% accuracy and within a given time period established by the instructor

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KEEPING FARM BUSINESS RECORDS	1. Given access to a particular farming operation and the past 3 years operating record as well as the appropriate recording forms	the student will: a. List and explain in writing ten (1)) resasons why farm records should be kept b. List and explain in writing five (5) types of important records that should be kept in order to provide an accurate financial picture of the farming operation c. Calculate depreciation, correctly enter the results in a farm inventory book and calculate net worth d. Using the cash account book and important records, correctly place and summarize the data in a Farm Cash Account booklet e. Set up Farm Machinery Operation and Maintenance Records f. Correctly enter and summarize the data in the Production Records forms g. Correctly record labor data in Labor Record book	according to directions in given record forms so that when analyzing the financial situation of the farm, an accurate analysis and interpretation can be made

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PREPARING FARM BUDGETS	1. Given access to records of a specific farming operation, including income and expense items, inventories of soil capability, machinery and equipment, and other data, together with appropriate outlook data from reliable sources (USDA and others)	the student will: a. Correctly set up budget(s) for given enterprise(s) b. Correctly set up a complete trial budget for given farming operation c. Set up a second complete trial budget and determine which budget would be the most profitable d. Accurately work out an operating budget for a specific year showing income and cash expense for each enterprise and the total farm business	according to recommended procedures in record book and with 95% accuracy

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Occupational Designation: Field Supervisor

U.S.O.E. CODE NUMBER: 01.0104

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
ANALYZING FARM BUSINESS RECORDS	1. Given access to farm business records and the responsibility of recommending ways for maximizing the farm operation	the student will analyze the farm business including: a. Developing a farm business summary b. Developing a farm business analysis c. Preparing 10 financial statement analysis measures for the farm business d. Prepare written recommendation for improving the efficiency of the farm business	with an arithmetical accuracy of 95% and in 90% conformity with analysis of Farm Management Specialist representing the Cooperative Extension Service in the local area

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
REPLANNING THE FARM BUSINESS FROM RECORD ANALYSIS	1. Given access to the previous 3 year records of a farm business	the student will: a. Set up partial budgets based on his estimates to determine the probable outcome of changes in given farming operation b. Set up an annual operating budget based on recommended changes showing cash income and expenditures for the farm business for the coming year c. Work out a cash flow budget showing estimates of cash income and expenditures, and allowance for income and social security taxes	according to recommended procedures of Farm Mangement Specialists and with 95% accuracy as determined by the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
FINANCING THE FARMING OPERATION	1. Given access to the financial records of a given farming operation	the student will: a. Prepare an analysis of 3 types of credit which may be appropriate for the farm including sources, costs and estimated returns to the farm business for the use of the credit b. Prepare an operating budget for the farm business c. Prepare an annual operating budget and other planned expenses in the total operation in preparing the cash flow budget	to the satisfaction of the instructor in terms of the recommendations and with 95% accuracy in terms of arithmetical computations
	2. Given the data developed in Objective 1 and approved by the instructor	the student will prepare applications for a short-term and a long-term loan including for each: a. Evidence of plan for expansion of the business b. Present financial condition of the business c. Proposed repayment schedule	to the satisfaction of the instructor or a representative of a local lending agency

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING AND SECURING FARM INSURANCE	1. Given a specific farm and farm family situation which is typical of the local community, together with insurance reference materials	the student will: a. Explain verbally or in writing the chances of loss, causes of loss and the effect of loss that may occur in a farm business b. Explain verbally or in writing the kinds of life insurance and give examples where each kind is well adapted c. Explain verbally or in writing the types of coverages available through different types of insurance plans (fire, crop, health, etc.) d. List and explain six (6) factors one should consider in selecting an agency from which to purchase insurance	to the satisfaction of the instructor or one or more local insurance executives and/or bankers designated by the instructor
	2. Given the material prepared for Objective 1 including information about the Farm Operator and the Farm Family	the student will plan the kinds of insurance and the approximate amounts he would recommend for the farm family	to the satisfaction of the instructor or one or more local insurance executives and/or bankers designated by the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
FULFILLING FARM TAX RESPONSIBILITIES	1. Given complete annual farm account records for a specific farm and information regarding the farm family and the appropriate forms and instruction book	the student will complete the state income tax report for the farm using the appropriate tax rate schedule and records including necessary supporting data	with 100% accuracy
	2. Given complete annual farm account records for a specific farm and information regarding the farm family and appropriate forms	the student will complete the Federal income tax report for the farm using the appropriate tax rate schedules and records including necessary supporting data	with 100% accuracy

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INTERPRETING AND UTILIZING FARM LAW	1. Given data on a specific farm operation on which production contracts have been (or may be) written	the student will prepare the data and materials to be submitted to an attorney for use in preparing a production contract for the farm. The materials will include the student's recommendation as to: a. The type of contract b. Provision for termination of the contract c. Provision for single proprietorship, partnership or corporate organization d. Recommendations as to qualification of the attorney who would write the contract e. Provisions in the contract relative to enforceability	to the satisfaction of the instructor or a local attorney designated by the instructor
	2. Given data on a specific farm operation in the local community including farm enterprises, equipment, labor markets, marketing practices and financial obligations,	the student will prepare written recommendations for the farm operator regarding: a. Major precautions which should be taken in using farm workers b. Landlord-tenant relationships c. Farm operator-employee relationships d. Drainage and water rights and responsibility	to the satisfaction of the instructor or of a legal authority he designates

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INTERPRETING AND UTILIZING FARM LAW		e. Pollution control responsibility f. Responsibilities regarding livestock g. Responsibilities regarding livestock diseases h. Responsibilities related to custom work done for others or done for the operator i. Regulations regarding trespassing	

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
UNDERSTANDING THE FUNCTIONS AND OPERATIONS OF FARMER COOPERATIVES	1. Given a group of fellow students or another similar group and appropriate materials on farmer cooperatives	the student will assist the group to organize a real (or simulated) farmer cooperative. In the process to organizing, the student will explain to prospective members: a. The basic principles of cooperative organization b. The advantages (and disadvantages) of cooperative organization for farmers c. The formation of the farmer cooperatives (marketing, supply, service, etc.) d. Financing the cooperative e. Functions and unique problems of managing a farmer cooperative	so that the organization formed by the student group conforms to the standards of the instructor or a farmer cooperative member he designates

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING GOVERNMENTAL SERVICES	1. Given a farm, or a larger agricultural area in the local community together with access to complete files of governmental agencies serving agriculture	the student will list and explain government programs which may be available to: a. Provide services to farmers b. Assist individuals to start farming c. Programs to protect consumers	so that he can present a list of governmental programs for agriculture from which selections may be made for local projects, and a list which is satisfactory to the instructor
	2. Given the data gathered in Objective 1 together with appropriate governmental forms and instruction book (or other sources)	the student will be able to apply for one or more specified governmental assistance programs for agriculture including: a. Securing the necessary forms and instructional materials b. Completing and submitting the forms	to the satisfaction of the instructor so that when the student is given the responsibility of obtaining, such services in a real setting, such services can be acquired in an efficient manner

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
COMMUNICATIONS IN AGRICULTURE	1. Given a problem or problem area related to agriculture or farm management	the student will: a. Define a topic for an oral presentation b. Prepare his speech c. Present his speech	to the satisfaction of the instructor or individuals he may designate
	2. Given the responsibility of preparing and presenting a two (2) minute radio spot announcement	the student will: a. Select an appropriate topic b. Prepare the announcement c. Present the spot announcement	according to accepted broadcasting standards approved by the station manager

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PERFORMING GENERAL OFFICE DUTIES	1. Given access to a common type office found on the farm	the student will: a. Answer the telephone b. Clearly converse on the telephone c. Take telephone messages accurately d. Place calls on the telephone e. Prepare and mail a business letter f. File various forms and reports g. Keep the office clean and organized	by following procedures of accepted general office practices

LIST OF MODULE TITLES AND STUDENT PERFORMANCE OBJECTIVES FOR PREPARING IRRIGATORS

DETERMINING THE FEASIBILITY OF IRRIGATING

PLANNING A SPRINKLER IRRIGATION SYSTEM

INSTALLING, OPERATING AND MAINTAINING MULTI-SPRINKLER SYSTEMS

INSTALLING, OPERATING AND MAINTAINING SINGLE-SPRINKLER SYSTEMS

INSTALLING, OPERATING, AND MAINTAINING BOOM-SPRINKLER SYSTEMS

INSTALLING, OPERATING, AND MAINTAINING PERMANENT-INSTALLATION SPRINKLER SYSTEMS

COMPILING INFORMATION NEEDED FOR DETERMINING IRRIGATION COST AND RETURN ON INVESTMENT

DETERMINING IRRIGATION COST AND RETURN ON INVESTMENT

SURVEYING LAND

SUPERVISING EMPLOYEES AND PERFORMING GENERAL OFFICE DUTIES

USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS

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Occupational Designation: Irrigator	U.S.O.E. CODE NUMBER: 01.0304

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING THE FEASIBILITY OF IRRIGATING	1. Given a specified area and the crops to be grown on the area	the student will: a. Determine the average amount and timeliness of rainfall in the area b. Determine how much increase in yield can be expected from irrigating field crops in the area c. List and explain several reasons why yields increase when ample water is available for irrigation d. Determine whether the field and soil conditions are such that an irrigation system can be operated satisfactorily e. List and explain other advantages of irrigating crops (e.g. protecting crops from frost and freezing; distribution of liquid fertilizers, pesticides, and animal waste) f. Determine the sources of adequate water g. Determine the availability of water h. Determine the quality of the water in the area	according to given charts,

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING THE FEASIBILITY OF IRRIGATING	2. Given information in regard to a farm area and the cropping program	the student will: a. Explain in writing the basic operating principles involved in common irrigation methods and systems used in the region b. Recommend an irrigation program for the farm area	to the satisfaction of the instructor and based on a 90% accurate appraisal as determined by the instructor or a person he/she designates

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Occupational
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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PLANNING A SPRINKLER IRRIGATION SYSTEM	1. Given the responsibility of planning a sprinkler irrigation system for an area of crop land to be planted	the student will: a. Make an inventory of available resources and operating conditions (e.g. information on soils, topography, water supply, source of power, crops, and farm operation schedules). b. Determine the depth or quantity of water to be applied at each irrigation c. Determine the depth or quantity of water to be applied at each irrigation d. Determine capacity requirements of the system e. Determine optimum water-application rate f. Determine type of sprinkler required g. Determine sprinkler spacing, discharge, nozzle sizes, and operating pressure for the optimum-application rate h. Determine number of sprinklers operating simultaneously required to meet system capacity requirements i. Determine the best layout of main and lateral lines	to the satisfaction of the instructor or an individual designated

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PLANNING A SPRINKLER IRRIGATION SYSTEM		for simultaneous operation and the required number of sprinklers j. Make necessary final adjustments to meet layout conditions k. Determine required sizes of lateral line pipe l. Determine maximum total pressure required for individual lateral lines m. Determine required sizes of main-line pipe n. Check main-line pipe sizes for power economy o. Determine maximum and minimum operating conditions p. Select pumps and power unit for maximum operating efficiency within range of operating conditions q. Prepare plans, schedules, and instructions for proper layout and operation	

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INSTALLING, OPERATING AND MAINTAINING MULTI-SPRINKLER SYSTEMS	1. Given access to the land area and cropping program and appropriate equipment and materials	The student will: a. Explain in writing how various types of multi-sprinkler irrigation systems operate b. Install a multi-sprinkler system c. Safely and efficiently operate a multi-sprinkler system d. Service a multi-sprinkler system e. Maintain a multi-sprinkler system	According to given plans and manual for operating, servicing and maintaining the system and to the satisfaction of the farm operator

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INSTALLING, OPERATING AND MAINTAINING SINGLE-SPRINKLER SYSTEMS	1. Given access to a land area and cropping system and needed equipment and materials	the student will: a. Explain in writing how various types of single-sprinkler systems operate b Install a single-sprinkler system c. Safely and efficiently operate a single-sprinkler system d. Service a single-sprinkler system e. Maintain a single-sprinkler system	according to given plans and manual for operating, servicing and maintaining the system

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INSTALLING, OPERATING, AND MAINTAINING BOOM-SPRINKLER SYSTEMS	1. Given access to appropriate equipment, materials and a land area with plants for a cropping program	the student will: a. Explain in writing how various types of boom-sprinkler systems operate b. Install a boom-sprinkler system c. Safely and efficiently operate a boom-sprinkler system d. Service a boom-sprinkler system e. Maintain a boom-sprinkler system	according to given plans and manual for operating, servicing and maintaining the system

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INSTALLING, OPERATING, AND MAINTAINING PERMANENT-INSTALLATION SPRINKLER SYSTEMS	1. Given access to appropriate equipment, materials and a land area with plans for the cropping program	the student will: a. Explain in writing how various types of permanent-installation sprinkler systems operate b. Install a permanent-installation sprinkler system c. Service a permanent-installation sprinkler system d. Maintain a permanent-installation sprinkler system	according to given plans and manual for operating, servicing and maintaining the system

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
COMPILING INFORMATION NEEDED FOR DETERMINING IRRIGATION COST AND RETURN ON INVESTMENT	1. Given the required data, the land area, and the crops to be grown	the student will assemble information needed to determine return on investment from the installation, including the following: a. Identify the crop to be irrigated b. Estimate the projected increase in yield as a result of irrigating c. Determine the value of the crop per unit d. Determine the maximum water intake rate in the soil e. Find the seasonal consumption use of the crop f. Determine the peak-rate demand rate of the crop g. Estimate the number of hours which the system will operate per day h. Determine the minimum number of days required for each irrigation i. Estimate the number of irrigations expected per season j. Determine the number of hours system will be operated k. Provide a sketch of the shape and dimensions of the field to be irrigated	with 95% accuracy in the calculations, and according to various charts and graphs so that the cost and return of the irrigation system can be determined

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
COMPILING INFORMATION NEEDED FOR DETERMINING IRRIGATION COST AND RETURN ON INVESTMENT		l. Determine the number of acres in the field m. Select a system for irrigating n. Determine the number of acres the system will irrigate in the field o. Find the pumping rate in gallons per minute p. Select a source of water q. Determine the total lift water is to be lifted and size of power unit needed (brake horsepower) r. Select the type of power unit (gasoline, diesel gas, or electric) needed for irrigating s. Determine the current interest rate t. Determine the amount of labor per acre per irrigation	
	2. Using the compilation of information in student performance objective number 1	the student will complete a cost and return form	that is legible with 95% accuracy

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING IRRIGATION COST AND RETURN ON INVESTMENT	1. Given specifications for purchase of a sprinkler irrigation system	the student will: a. Obtain the cost of each item needed for installing an irrigation system from a dealer or contractor and list these amounts in the correct column in a cost and return form b. Determine the total initial cost of items needed for installing an irrigation system and record this information in the appropriate space in a cost and return form	with 95% accuracy in the calculations and legible written statements in the correct column of the cost and return form
	2. Given the installation plans for the irrigation system including all specifications as to equipment, type and capacity	the student will: a. Use given table to determine the cost factors of each item based on a specified interest rate and the expected length of life and record this information in the cost and return form b. Determine the annual depreciation and interest for each item and record in the cost and return form c. Estimate annual cost of taxes and insurance and record	with 95% accuracy in the tabulations and legible written statements in the correct column in the cost and return form

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SURVEYING LAND	1. Given access to an area to be surveyed and the common types of surveying equipment	the student will: a. Recommend the most appropriate type of survey to use in surveying the area and give verbal reasons for selecting a specific type b. Identify and explain the uses of various types of surveying equipment c. Transport, carry, set-up, and maintain surveying equipment d. Calculate three (3) problems prepared by the instructor regarding the units of measurement used for surveying	to the satisfaction of the instructor, according to information in operator's manual and without damaging the surveying equipment
	2. Given access to appropriate surveying equipment and specific areas to be surveyed	the student will survey the areas using the following survey techniques: a. Basic surveying operations b. Differential leveling c. Profile d. Topographic e. Hand	with 95% accuracy and legible field notes recorded

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
SUPERVISING EMPLOYEES AND PERFORMING GENERAL OFFICE DUTIES	1. Given the task of supervising a group of employees and information relative to the type and quantity of work to be performed	the student will: a. Determine the number of employees needed and the abilities required to successfully complete the specified task b. Properly plan work loads and adequate working conditions for the employees c. Assign specific responsibilities to workers d. Supervise employees in carrying out their respective duties e. Evaluate the performance of workers	so that the employees are reasonably satisfied with their environment, and the work can be completed without additional cost and within the specified time period
	2. Given access to an office similar to a U.S. Soil Conservation Service Agent	the student will: a. Answer the telephone b. Clearly converse on the telephone c. Record adequate information from a call taken for someone else d. Place calls on the telephone e. Prepare and mail a business letter f. File various forms and reports g. Keep the office clean and organized	so that the communications in the office are clear and the office is conducive for maximum output and acceptable to the employer and/or the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	1. Given the appropriate information and the task of calculating agricultural problems relative to lengths	the student will: a. Identify and explain the uses of ten (10) units of lengths used in agriculture b. Convert units of length c. Determine the length of three (3) problems given by the instructor	so that the student will be proficient in calculating various lengths with a degree of accuracy established by the instructor prior to the beginning of the project
	2. Given the required information and the responsibility of calculating agricultural problems pertinent to areas of various shapes	the student will determine the areas for the following shapes: a. Square b. Rectangular c. Triangle d. Trapezoid e. Circle f. Irregular	to the satisfaction of the instructor and so that the student will be efficient in calculating problems on the farm which pertain to areas of various shapes
	3. Given needed information and the task of calculating agricultural volumes of various shapes	the student will determine the volumes for the following shapes: a. Cube b. Rectangle c. Pyramid d. Cylinder e. Cone f. Irregular	according to the accuracy and speed standards set by the instructor in calculating problems on the farm which pertain to the volumes of various shapes

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	4. Given the required information and the task of calculating agricultural problems in regard to weights	the student will: a. Identify and explain the uses of six (6) units of weights used in agriculture b. Convert units of weight c. Select and use scales in weighing agricultural commodities d. Determine weight by multiplying the unit weight times the calculated units in the total volume	so that the student will be proficient in determining the weight of various agricultural commodities with a degree of accuracy established by the instructor prior to the beginning of the project
	5. Given the required information and the task of calculating percentage problems relating to agriculture	the student will: a. List and explain three (3) ways of expressing per cent b. Convert decimals to percent c. Convert fractions to percent d. Explain and demonstrate the proper use of rules to use in solving problems involving percent	so that the student will be capable of determining percentages with a degree of accuracy established by the instructor prior to the beginning of the project
	6. Given the required information and the task of calculating given proportion problems relating to agriculture	the student will: a. Verbally explain ratio expressions three (3) ways b. Solve four (4) proportion problems given by the instructor	so that the student will be proficient in solving problems of proportion with a degree of accuracy established by the instructor prior to the beginning of the project

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
USING APPLIED MATHEMATICS IN SOLVING PRACTICAL AGRICULTURAL PROBLEMS	7. Given the required information and the task of calculating interest rates for a loan	the student will: a. Calculate simple interest rate b. Dollar cost c. True interest rate	with 95% accuracy and within a time period specified by the instructor
	8. Given the appropriate information and the task of calculating given depreciation problems	the student will calculate the following types of depreciation problems: a. Straight line b. Declining balance c. Sum of the digits	with 95% accuracy and within a given time period established by the instructor

LIST OF MODULE TITLES AND STUDENT PERFORMANCE OBJECTIVES FOR PREPARING GRAIN DRIER OPERATORS

INSTALLING AND MAINTAINING GRAIN DRYING FACILITIES

UNDERSTANDING THE BASIC OPERATING PRINCIPLES OF AND CARING FOR ITEMS ASSOCIATED WITH A DRYING SYSTEM

UNDERSTANDING THE PRINCIPLES OF DRYING CORN

DETERMINING WHEN TO HARVEST GRAIN CROPS

DRYING SHELLED CORN

AERATING STORED CORN

MOVING CORN IN A MATERIALS HANDLING SYSTEM

LOADING GRAIN CROPS FOR MARKETING

PREVENTING AND CONTROLLING INSECTS WHILE STORING GRAIN

PREVENTING AND CONTROLLING RODENTS WHILE STORING GRAIN

PERFORMING GENERAL OFFICE DUTIES

REPAIRING FARM BUILDINGS

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VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Grain Drier Operator

U.S.O.E. CODE
NUMBER: 01.0102

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
INSTALLING AND MAINTAINING GRAIN DRYING FACILITIES	1. Given a site for the installation of grain drying equipment in addition to access to appropriate supplies and equipment, and the manufacturer's installation instructions	the student will prepare the site and install the equipment including: a. Determining materials needed (cement, bolts, etc.) b. Constructing the foundation c. Adjusting the drying equipment for proper operation	according to the manufacturer's specifications (electrical installation for operation should probably be made by a licensed electrician)
	2. Given access to a grain drying system together with the operator's manual for the system	the student will operate and maintain the system including: a. Periodic inspection for defective parts b. Oiling and lubricating parts c. Repairing and/or replacing parts not requiring the services of a licensed workman	according to manufacturer's recommendations and as determined by the instructor or employer

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VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Grain Drier Operator

U.S.O.E. CODE
NUMBER: 01.0102

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
UNDERSTANDING THE BASIC OPERATING PRINCIPLES OF AND CARING FOR ITEMS ASSOCIATED WITH A DRYING SYSTEM	1. Given access to various types of items associated with drying systems	the student will: a. List and explain the basic operating principles of the various types of fans available for use in drying grain crops b. Identify two types of heater units and explain their basic principles of operation c. Identify other items commonly found as a part of a drying or storage system (e.g. grain distributor and various types of augers) and explain their basic operating principles	according to operator's manuals related to various systems
	2. Given access to items associated with a drying system and the task of servicing and storing	the student will: a. Use the required equipment to make adjustments and service the items b. Properly care for and store the items	according to recommendations of manufacturer

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Occupational
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U.S.O.E. CODE
NUMBER: 01.0102

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
UNDERSTANDING THE PRINCIPLES OF DRYING CORN	1. Given a quantity of corn to be dried, together with manuals describing various types of drying equipment and a grain drying bin	the student will prepare directions for drying the corn, including explanation and/or recommendations regarding: a. Basic principles involved in drying corn b. Equilibrium moisture content c. Advantages and disadvantages of heated and unheated air for drying corn d. Determining the drying zone in a bin	to the satisfaction of the instructor or an individual he/she designates

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DETERMINING WHEN TO HARVEST GRAIN CROPS	1. Given access to a grain crop to be harvested, moisture testing devices, and appropriate information	the student will determine when grain is ready for harvesting under various harvesting methods applying the following: a. Advantages of mechanical drying b. Calculation of moisture content of the grain c. Moisture test grain	to the satisfaction of the instructor and the procedures for operating the devices as suggested by the manufacturer

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
DRYING SHELLED CORN	1. Given access to recently harvested corn being delivered to a storage facility	the student will: a. Weigh and record each load of arriving grain b. Mechanically unload and transport grain to designated drying area c. Take a representative sample of grain d. Determine and record the moisture content	with a minimum loss of grain with ±5% accuracy of moisture content and with 98% accuracy in terms of weight of grain delivered to the facility as determined by the instructor or the employer
	2. Given access to the three main types of shelled corn drying systems	the student will dry shelled corn by each of the following systems and prepare a (written or oral) report explaining the differences between the systems: a. In-storage layer b. Batch drying system c. Continuous flow drying system	according to the directions in operator's manuals

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
AERATING STORED GRAIN	1. Given access to an aeration system for stored grain	the student will: a. Explain verbally the differences between in-storage drying and aeration b. Verbally explain the functions of an aeration system c. Verbally explain the conditions under which an aeration system should be used d. Operate the system in aerating stored grain e. Make required adjustments and service the equipment	operation, adjustment and service of equipment will be according to the operator's manual and so that the grain is dry cooled and the temperature in the bin is equalized according to specifications and the explanations are made to the satisfaction of the operator of the stored grain facility or to the instructor

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
MOVING CORN IN A MATERIALS HANDLING SYSTEM	1. Given the responsibility of drying corn with the use of a materials handling system	the student will: a. Explain in writing the operating principles of the materials handling system used to dry corn b. Operate the materials handling system to dry corn	according to operator's manual so that the corn is dried as specified. The explanation of operating principles is satisfactory to the operator of the facility or to the instructor
	2. Given access to a materials handling system and the task of servicing and storing corn	the student will: a. Use appropriate tools to make adjustments in the system b. Select and use service equipment to service the system c. Properly store parts of the materials handling system	according to recommendations of manufacturer

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
LOADING GRAIN CROPS FOR MARKETING	1. Given access to a materials handling system, transporting vehicle, and the task of loading grain	the student will: a. Weigh and record the weight of the transporting vehicle (trucks, wagons, railroad cars) b. Operate a materials handling system in loading grain on various types of transporting vehicles c. Weigh and record the load of grain on the appropriate form	with minimum loss of grain, 100% accuracy on all weights as verified by a supervisor and operation of equipment according to the operators manual and to the satisfaction of the operator of the facility
	2. Given the responsibility of servicing a weighing scale and a materials handling system	the student will: a. Make adjustments and lubricate the weighing scale b. Adjust parts of materials handling system c. Lubricate parts of the materials handling system d. Properly store parts of the materials handling system	according to the manufacturer's recommendations and so that the equipment will operate safely and efficiently

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PREVENTING AND CONTROLLING INSECTS WHILE STORING GRAIN	1. Given access to an area where grain is stored and a problem with insects	the student will: a. Identify the type(s) of insects which are damaging the stored grain b. Determine areas where the insects are located and multiply c. Select and apply sprays to control insects d. Select and apply powders in controlling insects e. Select and apply fumigants to control insects f. Keep records on various methods used to control insects	Selection of control materials is in line with recommendations of pest control authorities in the Cooperative Extension Service and the FDA and are applied according to the directions of the manufacturer as determined by the operator of the facility. Identification and location of insects in the grain is 100% accurate as determined by the operator of the facility
	2. Given access to chemical applicators used in controlling insects	the student will: a. Lubricate equipment b. Clean applicator c. Store equipment	according to operator's manual so that the equipment will continue to operate safely and efficiently

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PREVENTING AND CONTROLLING RODENTS WHILE STORING GRAIN	1. Given access to an area where grain is stored and a problem with rodents	the student will: a. Identify the type(s) of rodents which are damaging the stored grain b. Determine areas where the rodents are located and where they multiply c. Select and apply appropriate sprays to control rodents d. Select and apply baits to control rodents e. Select and apply fumigants to control rodents f. Keep records on effectiveness of various methods	Selection of control materials is in line with recommendations of pest control experts in the Cooperative Extension Service and the FDA, and are applied according to the manufacturers directions as determined by the operator of the facility. Identification and location of rodents breeding places is 100% accurate as determined by the operator of the facility
	2. Given access to chemical applicators used in controlling rodents	the student will: a. Lubricate applicator b. Clean applicator c. Store applicator	according to operator's manual so that the equipment will continue to operate safely and efficiently

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
PERFORMING GENERAL OFFICE DUTIES	1. Given access to a common type of office setting	The student will: a. Answer the telephone b. Clearly converse on the telephone c. Take telephone messages accurately d. Place calls on the telephone e. Prepare and mail a business letter f. File various forms and reports g. Keep the office clean and organized	by following procedures of accepted general office practices

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MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
REPAIRING FARM BUILDINGS	1. Given access to equipment and materials and the responsibility of repairing a farm building	the student will: a. Determine and select the materials (roofing, siding, foundation, etc.) needed for repairing the building b. Repair the foundation by mixing and pouring concrete c. Replace broken windowpanes d. Repair doors and gates and hang them e. Repair wood siding and add braces to farm building f. Repair the roof	according to recommendations of construction and materials supply specialists and in accordance with the directions of the farm operator

A SET OF MODULES FOR PREPARING WASTEWATER TREATMENT OPERATORS

MODULE OF INSTRUCTION

CODE--01.99

DETERMINING OCCUPATIONAL OPPORTUNITIES AND SECURING EMPLOYMENT IN WASTEWATER TREATMENT SYSTEMS

Module Concept: Because of water pollution standards, conventional wastewater treatment systems will have to be up-dated. New systems will also have to be constructed in many communities to meet water pollution standards. More competent people will be needed in the future to operate up-dated and newly constructed wastewater treatment systems. Opportunities will also be available in enterprises related to treating and reusing waste materials. By studying the various occupations in treating and reusing waste, the student will be able to consider various factors, such as working conditions, salary and educational requirements for entry that will influence his/her career choice.

Prerequisites: No major prerequisites are required by the student to master this module. The student should be able to read and comprehend basic information.

Module Goal: When this module of instruction is completed, the student should be fully aware of the occupational opportunities in systems where wastewater materials are treated properly and reused.

Student Performance Objective 1: In seeking information about job opportunities in wastewater treatment systems, the student will conduct personal surveys or obtain literature that will assist him or her in determining the number and kind of job opportunities which are available in systems where wastewater is treated.

Instructional Areas:

1. Assessing job opportunities available in wastewater treatment systems

a. Locating information regarding the scope of occupations and opportunites for employment

   (1) Wastewater treatment operators
   (2) Wastewater treatment laboratory technicians
   (3) Irrigator (sprinkler systems)
   (4) Managers of farming operations using wastewater in growing agricultural crops
   (5) Supervisors of farming opera using wastewater in growing agricultural crops
   (6) Farm equipment operators
   (7) Grain drier operators
   (8) Agricultural equipment mechanics

b. Determining how to plan and conduct personal interviews

   (1) Preparing surveys
   (2) Scheduling interviews
   (3) Probing for answers when interviewing
   (4) Writing down comments when interviewing
   (5) Interpreting comments after interviewing

c. Surveying local, state and national levels relative to number of job openings per year and future employment needs

d. Locating information relative to enterprises where training could be used to work in related occupations

   (1) Local, state and federal governmental occupations
   (2) Private enterprises

Examples of Supporting References:

1. U.S. Department of Labor, Bureau of Labor Statistics, *Occupational Outlook Handbook 1974-75 Edition*. Washington, D.C. : Government Printing Office.

2. Hoover, Norman K. Handbook of Agricultural Occupations: Danville, Illinois: The Interstate Printers and Publishers, Inc. 1969.

3. Opportunities in Agricultural Occupations and the Employee Within the Business Organization. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University, 1971.

Examples of Student Learning Activities:

1. The instructor may have students conduct personal surveys in the local community to determine the number of employees in occupations related to water and wastewater treatment systems and number of openings each year in the following operations:
    a. Wastewater treatment systems
    b. Farming operations where waste is used in growing agricultural crops
    c. Public health
    d. Food processing industries

2. In a simulation arrangement, each student in the class should demonstrate to other classmates correct procedures and techniques in conducting personal interviews.

Examples of Evaluation Techniques:

1. Have students develop a brief personal survey form for determining the number of persons in occupations related to water and wastewater treatment systems and the number of openings in a given industry.

2. Given four different persons to be interviewed, the student should be capable of scheduling the interview by making telephone calls and writing confirmation letters to the satisfaction of the instructor.

Instructional Resources:

1. Appropriate tables, desks, chairs and tape recorder or video tape machines necessary for conducting simulated personal surveys.

2. Written notices from newspapers, journals and other publications listing information relative to employment trends and job openings in occupations related to treating water and wastewater.

Student Performance Objective 2:

Given a specific occupation which the student is interested in, the student will determine the competencies and educational requirements needed by persons to enter and advance in that career.

Instructional Areas:

1. Determining educational requirements necessary for employment and major emphasis of study
    a. High School diploma
    b. Two-year associate degree
    c. Four-year college degree
    d. Master's degree
    e. Doctor's degree
2. Determining the competencies needed for employment
    a. Technical skills
    b. Knowledges
    c. Basic reading, mathematical and writing skills
    d. Behaviors
    e. Personal traits
3. Determining occupational work experiences needed for employment
4. Securing occupational work experience
    a. Public and private school educational laboratories
    b. Public agencies
    c. Private enterprises
    d. Non-profit organizations
5. Determining occupational benefits

- a. Considering wages and salaries
    - (1) Daily
    - (2) Weekly
    - (3) Monthly
    - (4) Annually
- b. Determining insurance benefits
    - (1) Health
    - (2) Life
- c. Determining leave days
    - (1) Vacation
    - (2) Illness
    - (3) Emergency
    - (4) Business
- d. Considering retirement benefits
- e. Working conditions

6. Considering federal and state regulations which apply to various occupations

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Examples of Supporting References:

Supporting references were depicted under Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may identify several occupations related to treating water and wastewater and have the students determine minimum educational and occupational work experience requirements for each occupation.

2. In a class discussion, the instructor may have students discuss the following factors regarding the employment benefits of a wastewater treatment operator and wastewater treatment plant manager. In discussing the two occupational benefits, the students should identify possible reasons for differences.
    - a. Annual wage and/or salary
    - b. Vacation time
    - c. Retirement benefits
    - d. Life insurance

Examples of Evaluation Techniques:

1. The instructor may have students determine the weekly and annual salary of wastewater treatment personnel who earn $50/day and work five days a week.
2. When asked to explain the job description of a specific occupation, the student should be able to explain the job description to the satisfaction of the instructor.

Instructional Resources:

1. Several written employment contracts
2. Several job postings
3. U.S. Department of Labor, Bureau of Statistics, Occupational Outlook Handbook 1974-75 Edition.

Student Performance Objective 3:

Upon identifying a job in which the student is interested, the student will follow the proper procedures necessary to be placed in the job.

Instructional Areas:

1. Preparing a resume
    a. Including appropriate information elements in resume
    b. Organizing content in resume
    c. Typing resume
    d. Preparing copies
2. Securing references
    a. Identifying individuals for writing reference letters
    b. Writing letters requesting reference letters
    c. Having letters sent to appropriate placement offices and employment agencies.
    d. Following up on reference letters
3. Locating potential jobs through various sources
    a. Public placement offices
    b. Educational placement services
    c. Private agencies

4. Interpreting job description and ones' aptitude and interests

5. Applying for a job

   a. Writing a letter of application
   b. Completing application
   c. Conducting the personal interview

Examples of Supporting References:

1. Shannon, Theodore. Deciding On and Locating Your Kind of Job. Ohio Agricultural Education Curriculum Materials Service, The Ohio State University, Columbus, Ohio 43210.

2. Shannon, Theodore. Getting Your Job. Ohio Agricultural Curriculum Materials Service, The Ohio State University, Columbus, Ohio 43210.

Examples of Student Learning Activities:

1. The instructor may desire to collect applications from several businesses and industries in the area and have students complete several different types of applications.

2. In a simulated exercise, have students demonstrate the correct procedures and techniques in conducting a personal interview.

Examples of Evaluation Techniques:

1. The instructor may have students study job listings in the local newspaper and have students write a letter of inquiry to the satisfaction of the instructor.

2. The instructor may have students prepare resumes of themselves to the satisfaction of the instructor.

Instructional Resources:

1. Sample resumes
2. Sample letters of inquiry
3. Several types of applications
4. Several job postings
5. Visitation to an employment agency

MODULE OF INSTRUCTION

CODE--01.99

USING SAFETY PRACTICES IN OPERATING WASTEWATER TREATMENT SYSTEMS

Module Concept: On a man-hour basis, wastewater treatment plant accidents and deaths are considerably higher than those occurring in factories. Accident prevention is a result of thinking ahead and understanding the hazards and dangers one may face while working in a Wastewater Treatment System.

The purpose of this module is to depict for the student the importance of using safety practices while working in Wastewater Treatment Systems. This module also explains safety practices which should be performed by workers on the site.

Prerequisites: Admission in the Environmental Technology Program is sufficient evidence of qualification for entry into the course. A relevant course in basic first aid is suggested.

Module Goal: When this module of instruction is completed, the student will be able to work safely in Wastewater Treatment Systems.

Student Performance Objective 1: While touring or working in the building of a wastewater treatment system the student will:

a. Verbally identify safety equipment by their common names and explain their uses
b. Give verbal reasons why the equipment is located in various areas in the building

according to the manufacturer's identification of equipment.

Instructional Areas:

1. Identifying safety equipment and determining their uses
   - a. Traffic warning signs
   - b. Safety harnesses
   - c. Rubber gloves and boots
   - d. Electric cap lamps
   - e. Warning signs
   - f. Fire extinguishers for all types of fires
   - g. Breathing apparatus
   - h. Inhalators
   - i. Portable blowers
   - j. Oxygen-deficiency indicators
   - k. First aid kits
   - l. Chlorine detection products
   - m. Life preservers
2. Locating safety equipment for protection

Examples of Supporting References:

1. Operation of Wastewater Treatment Plants. Water Pollution Control Federation. WPCF Manual of Practice No. 11. Washington, D.C. 1970. pp. 169-177.

2. Safety in Wastewater Works. Water Pollution Control Federation. WPCF Manual of Practice No. 1. Washington, D.C. 1969.

3. Manual of Instruction for Sewage Treatment Plant Operators. Health Education Service. P.O. Box 7283 Albany, N.Y. 12224.

4. Wastewater Treatment Plant Operator Training Course Two. Water Pollution Control Federation. WPCF Publication No. 14. Washington, D.C. 1967. pp. 107-118.

5. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970.

Examples of Student Learning Activities:

1. The instructor and students may visit a wastewater treatment system and have several students identify the safety equipment used on the site.

2. The instructor may have several students locate safety equipment and explain why the equipment is located in given areas.

3. The student may demonstrate the use of various safety equipment.

4. The instructor may invite individuals in the fire department to demonstrate to students methods of artifical respiration and other rescuing methods using various safety equipment.

Examples of Evaluation Techniques:

1. The instructor may prepare a diagram of a wastewater treatment site, present each student with a diagram and have them fill in the name and locations of at least 8 items of safety equipment that should be on the site.

2. The instructor may prepare a list of 12 items of safety equipment used in a wastewater treatment system and ask the students to list after each item at least one use for each. Additional credit may be given when students list more than one use.

Instructional Resources:

1. Filmstrips and movies of safety practices which should be used in wastewater treatment systems.
2. Various types of safety eqipment mentioned in Instructional Areas
3. Pamphlets on safety

Student Performance Objective 2:

Given several objects to be relocated in a wastewater treatment system, the student will mechanically relocate the objects in the designated area without damaging the objects, or mechanical equipment or injuries to workers.

Instructional Areas:

1. Manually relocating objects
    a. Using appropriate techniques for relocating objects
    b. Wearing appropriate clothing
    c. Determining feasibility for manually relocating objects
    d. Determining where to relocate objects
    e. Placing and securing objects
    f. Using the wrecking bar
    g. Using ramps and platforms
    h. Using safety practices
2. Mechanically relocating objects
    a. Identifying various types of equipment and their uses
        (1) Lift trucks
        (2) Mechanical and electrical hoists
    b. Operating mechanical and electrical equipment
        (1) Identifying and using safety practices
        (2) Determining lifting capacity of equipment
        (3) Wearing appropriate clothing
        (4) Determining where to relocate objects
        (5) Placing and securing objects

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a large empty box, the instructor may have the student demonstrate the proper techniques of manually picking up the box and relocating it from one side of the room to the other.

2. Given mechanical or electrical hoists, the instructor may have the student demonstrate the proper techniques of loading a large empty box on a truck.

Examples of Evaluation Techniques:

1. Given a large box to relocate, the student should demonstrate the proper techniques of picking-up and relocating the box to the satisfaction of the instructor.
2. Given an electrical hoist, the student must be able to explain and demonstrate the proper use of the equipment to the satisfaction of the instructor or wastewater treatment personnel.
3. The instructor may obtain a diagram of the human body muscle and bone structure from the biology teacher and ask the students to use it to explain at least 3 places where and how the body may be injured when proper techniques of lifting, pulling and pushing are not performed properly.

Instructional Resources:

1. Hoists
2. Diagrams of the human body
3. Equipment used for lifting and moving heavy objects such as crowbars, ramps and hoists

Student Performance Objective 3:

When visiting a collection and pumping station, the student will identify and verbally explain the types and locations of hazardous conditions at the sites as specified by the employer and to the satisfaction of the instructor.

Instructional Areas:

1. Identifying the types of physical injuries that may occur at the collection and pumping sites
    a. Falling
        (1) Using ladders
        (2) Icy conditions
        (3) Entering and exiting manholes
    b. Opening and closing manholes
    c. Moving traffic
        (1) Using traffic warning signs
        (2) Using guard rails and manhole cages

   - d. Preventing injuries while using tools and equipment

2. Determining practices used to prevent body infections
   - a. Washing and/or bathing at appropriate times
   - b. Keeping fingers out of mouth, eyes and ears
   - c. Receiving proper innoculations
   - d. Wearing appropriate clothing

3. Identifying monitoring equipment used at the sites
   - a. Warning buzzers and lights when entering hazardous areas
   - b. Warning lights and buzzers to identify defective equipment

4. Identifying oxygen deficiency conditions
   - a. Entering and working in deep sewer manholes
   - b. Entering and working in covered tanks
   - c. Entering and working in underground structures
   - d. Working in areas where ventilation is limited

5. Identifying noxious gases and vapor conditions
   - a. Burning or exploding conditions
   - b. Asphyxiating conditions
   - c. Poisioning conditions

Examples of Supporting References:

In addition to the supporting references discussed under Student Performance Objective 1, the following may be found useful:

1. Clean Hands. FDA 72-2031. Washington, D.C. Public Health Service, Food and Drug Administration, U.S. Department of Health, Education and Welfare, U.S. Government Printing Office. 13 pages.

2. Shannon, Theodore. Taking Care of Yourself. Columbus, Ohio. Ohio Agricultural Education Curriculum Materials Service, Ohio State University. 1972. 27 pages.

Examples of Student Learning Activities:

1. The instructor and students may visit a wastewater treatment collection and pumping station and have several students identify the locations and types of hazards on the site that may cause physical injury.

2. The instructor may have several students wash their hands by using correct hand washing techniques.

3. While visiting a wastewater treatment collection and pumping station, the instructor may have several students identify the locations and types of oxygen deficiency, noxious gases and vapor hazardous conditions found on the sites.

Examples of Evaluation Techniques:

1. Given a ladder at least 6 feet long, the student should be able to demonstrate the safe use of the ladder and explain the conditions which can result from improper use to the satisfaction of the instructor.

2. Given soap, running water and towels, the student should be able to wash his/her hands to the satisfaction of the instructor.

3. The instructor may prepare diagrams of the collection and pumping station, present one to each student and have them locate at least 4 areas where oxygen deficiency or posionous gas conditions could develop.

Instructional Resources:

1. Movies, filmstrips or slides
2. Appropriate projectors and screen
3. First aid kit
4. Oxygen-deficiency and gas detection equipment
5. Appropriate tools for opening manholes and performing other necessary tasks related to safety
6. A ladder at least 6 feet long
7. Soap and towels

Student Performance Objective 4:

While visiting the aeration treatment cell site, the student will identify and verbally explain the types and locations of hazardous conditions as specified by the employer and to the satisfaction of the instructor.

Instructional Areas:

1. Identifying the types of physical injuries that may occur at the aeration treatment cell site.

    a. Falling conditions

        (1) Using Ladders
        (2) Icy conditions
        (3) Using steps and handrails
        (4) Using adequate lighting

    b. Preventing injuries while using tools and equipment

    c. Preventing electrical shocks and burns

2. Identifying safety monitoring equipment at the site in determining defective equipment.
    a. Listening and interpreting warning buzzer sounds
    b. Observing and interpreting lights

Examples of Supporting References:

Supporting References were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. After a rainy day, the instructor may have student identify some hazardous conditions created by heavy rainfall at the site in the aeration cells. The instructor may also have the students explain what measures should be taken to prevent the problem at a later date.

2. The instructor may ask students to bring to class from newspapers and magazines examples of accidents that have recently taken place at wastewater treatment systems.

Examples of Evaluation Techniques:

1. Given an electrical motor with wiring which has lost part of its' insulation, the student should be able to demonstrate with a line tester the hazardous condition created and explain the types of injuries that could result from such defects to the satisfaction of the instructor.

2. Given a hammer, the student should be able to demonstrate the safe use of the hammer by nailing two pieces of wood together to the satisfaction of the instructor.

3. Given an electrical hand drill, the student should be able to demonstrate the safe use of the drill by drilling a hole in at least 1/8 inch metal to the satisfaction of the instructor.

4. The student should be able to replace a light bulb in a safe manner to the satisfaction of the instructor.

Instructional Resources:

1. Charts and diagrams of aeration treatment cells
2. Access to an aeration treatment cell site
3. Ladder
4. Used electrical motor with electrical cord attached
5. Light bulb
6. Protective clothing
7. Access to aeration safety monitoring equipment

Student Performance Objective 5:

While visiting the storage and disinfection sites, the student will identify and verbally explain the types and locations of hazardous conditions on the site, as specified by the employer and to the satisfaction of the instructor.

Instructional Areas:

1. Identifying the types of physical injuries that may occur at the storage and disinfection site.
    a. Falling conditions
        (1) Using steps and handrails
        (2) Icy conditions
        (3) Wet and slippery conditions
    b. Preventing injuries while using tools and equipment
    c. Moving traffic
        (1) Driving carefully
        (2) Walking carefully
2. Identifying precautions necessary in operating chlorine equipment
    a. Heating and ventilating the chlorine room
    b. Providing ample working space
    c. Following appropriate procedures for handling cylinders
        (1) Keeping cylinders away from heat
        (2) Using protective cylinder caps when moving cylinders
        (3) Lifting cylinder with approved equipment

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. While driving along the banks of the storage lagoons, the instructor may ask several students to identify various locations where careful driving is essential to prevent accidents.

2. Using simulation techniques, several students may debate the precautions necessary in operating chlorine equipment.

Examples of Evaluation Techniques:

1. The student should be able to drive a pick-up truck around the lagoon area in a safe manner to the satisfaction of the instructor.

2. Given a chlorine cylinder to be changed, the student must be able to demonstrate the techniques which should be used in disconnecting and connecting the chlorine cylinder without injuring himself or others.

Instructional Resouces:

1. Charts and diagrams
2. Pamphlets on handling chlorine
3. Ammonia
4. Breathing apparatus
5. Access to a storage and disinfection site
6. Access to hand and electrically operated tools
7. Protective clothing used in wastewater treatment systems
8. Chlorine cylinders used in wastewater treatment systems

Student Performance Objective 6:

While visiting the spray irrigation area, the student will identify and verbally explain the types and locations of hazardous conditions as specified by the employer and to the satisfaction of the instructor.

Instructional Areas:

1. Identifying the types of physical injuries that may occur at the spray irrigation sites.

    a. Movement of the spray irrigation equipment
    b. Damaged or worn electrical wires
    c. Defective equipment

2. Preventing physical injuries while working on or near the spray equipment.

    a. Preventing injuries while operating equipment and using hand tools
    b. Preventing electrical shocks and burns
    c. Driving carefully in the area due to rough roads and water conditions
    d. Using the monitoring equipment to check for defective equipment

Examples of Supporting References:

Lockwood Waste Water Spray Irrigation System. Operators Manual for the Muskegon System. Manual No. 7900-0012.

Examples of Student Learning Activities:

1. Given deep furrows in the field caused by the irrigation rig, the instructor may have a student correct the situation to enable safe driving of vehicles to the rig.

2. Given a tire on the irrigation rig to be changed, the student will demonstrate to the instructor the proper techniques in changing the tire.

Examples of Evaluation Techniques:

1. Given a panel with operating controls, the student should be able to demonstrate to the instructor the proper technique in turning off the spray irrigation rig.

2. Given a tire on the irrigation rig to be changed, the student will demonstrate to the instructor the proper techniques in changing the tire.

Instructional Resources:

1. Charts and diagrams of the system
2. Access to a spray irrigation site
3. Access to pick-up truck
4. Protective clothing
5. Jack and tire repair equipment
6. Access to spray monitoring equipment

Student Performance Objective 7:

Given a simulated accident on the wastewater treatment site, the student will properly file an accident report according to the actual occurance.

Instructional Areas:

1. Investigating the injury

    a. Visiting the scene of the accident
    b. Interviewing the injured person
    c. Interviewing any witnesses

2. Writing an accident report accurately

3. Using appropriate procedures in filing an accident report

Examples of Supporting References:

Safety in Wastewater Works. Water Pollution Control Federation. WPCF Manual 1. Washington, D.C. 1969. pp. 47.

Examples of Student Learning Activities:

1. The instructor may describe a simulated accident, and have several students interview the victims, visit the site of the simulated accident and interview the witnesses.
2. Have students use appropriate procedures in filing an accident report in a simulated exercise.

Examples of Evaluation Techniques:

1. Given an accident report form and details of an accident, the student should be able to complete the form with 90% accuracy.
2. The instructor may prepare in written form the details of an accident, with the instructor acting as the victim, the student should be able to interview the "victim" concerning the details of the accident to the satisfaction of the instructor.

Instructional Resources:

1. Copies of an accident report form commonly used on a wastewater treatment system for each student.
2. Pamphlets on how to file accident reports.

Student Performance Objective 8:

When visiting the workshop area of the wastewater treatment system, the student will identify and explain the types and locations of hazardous conditions on the site as specified by the employer and to the satisfaction of the instructor.

Instructional Areas:

1. Identifying the types of physical injuries that may occur in the workshop.
    a. Using hand tools
    b. Using power tools
    c. Using the arc welder
    b. Using the oxy-acetylene welder

2. Detecting harmful gaseous and vapor conditions

    a. Working in areas where ventilation is limited
    b. Using oxy-acetylene and arc welders
    c. Painting

Examples of Supporting References:

Wakeman T.J. and Vernon Lee McCoy, The Farm Shop. New York: The Macmillian Company. 1960.

Examples of Student Learning Activities:

1. The instructor may ask the students to conduct a survey of workshops in the area to determine the types of hazards in such work areas.

2. Given oxy-acetylene equipment, the instructor may have several students identify several hazardous conditions to avoid while operating the equipment in workshop.

Examples of Evaluation Techniques:

1. Given oxy-acetylene equipment, the student should be able to neatly cut a piece of 1/4 inch steel rod without causing injury to himself or damage to the equipment.

2. Given a work area with the doors and windows closed and the exhaust system closed, the student should be able to properly ventilate the room for arc welding to the satisfaction of the instructor.

Instructional Resources:

1. Access to a wastewater treatment workship site
2. Arc and oxy-acetylene welding equipment
3. Fans or exhaust equipment
4. Protective clothing
5. Hand operated and electrically powered tools

MODULE OF INSTRUCTION

CODE--01.99

INTERPRETING CODES, CONTRACTS AND POLLUTION STANDARDS IN WASTEWATER TREATMENT SYSTEMS

Module Concept: Wastewater treatment personnel are often given managerial responsibilities which require the workers to be able to read and interpret contracts, codes and pollution standards as well as become concerned with legal problems relating to wastewater treatment systems. Since effluent quality must meet permit requirements where laws are involved, the wastewater treatment personnel must be able to understand the legal aspects of the system and the requirements that must be met.

The purpose of this module is to depict for the instructor areas which should be taught relative to the use of contracts, codes and standards in wastewater treatment systems.

Prerequisites: Admission to the Environmental Technology Program is sufficient evidence of qualifications for entry into the course.

Module Goal: When this module is completed, the student will be able to read and interpret contracts, codes and pollution standards and perform tasks that are necessary for the legal operation of a wastewater treatment system.

Student Performance Objective 1: Given various contracts relating to wastewater treatment systems, the student will read and interpret the contract verbally or in writing so well that the interpretations of the contracts meet the approval of the instructor.

Instructional Areas:

1. Identifying the elements and purposes of a contract
    a. Involving two or more competent parties
    b. Having a mutual agreement
    c. Involving valuable consideration
    d. Binding legal obligations
    e. Considering the form format
2. Establishing contract documents

a. Advertising contracts which include the following elements:

   (1) Name
   (2) Location
   (3) When & where received
   (4) When & where opened
   (5) Addressing
   (6) General description
   (7) Plans and specification location
   (8) Copies obtainable
   (9) Owner statement
   (10) Bid bond
   (11) Special requirements (if any)
   (12) Name of individual publishing

b. Instructing bidders which includes the following elements:

   (1) Description
   (2) Proposals
   (3) Bid requirements
   (4) Contract data
   (5) Bond
   (6) Time limits
   (7) Standard specifications
   (8) Estimates
   (9) Contract documents

c. Preparing proposals

   (1) Form
   (2) Lump sum
   (3) Unit price
   (4) Witness

d. Considering general conditions

   (1) Intent
   (2) Definitions
   (3) Bond requirements
   (4) Reports and payments
   (5) Modification of contractual relations
   (6) Business details
   (7) Conduct
   (8) Completion and acceptance

e. Establishing agreements

   (1) Parties involved
   (2) Scope of work

    (3) Time
    (4) Price
    (5) Payment
    (6) Proof of outstanding invoices

  f. Determining elements of performance bonds

    (1) Surety company
    (2) Amount

3. Checking general specifications in contracts to make sure that they are:

    a. Complete as possible
    b. Clearly understood
    c. Brief as possible
    d. Definite as possible
    e. Fair as possible

Examples of Supporting References:

1. Mead, Daniel W., and others. Contracts, Specifications and Engineering Relations. New York: McGraw-Hill Book Co., Inc. Current Edition.

2. Merritt, Frederick S., Building Construction Handbook. New York: McGraw-Hill Co., Inc. Current Edition.

Examples of Student Learning Activities:

1. The instructor may ask several students to watch their local newspapers and bring to class advertisements for contracts and discuss bidding requirements.

2. Given several types of contracts, the instructor may ask two students to read the instructions and explain the tasks to be performed by the contract recipient.

Examples of Evaluation Techniques:

1. Given a contract advertisement, the student should be able to read the advertisement and list to the satisfaction of the instructor any special requirements that are necessary for bidding.

2. Given several types of contracts, the instructor may ask two students to read the instructions and give the time limits set for the completion of various stages in the project.

Instructional Resources:

1. Examples of contracts
2. Examples of contract documents
    a. Advertisements
    b. Instructions to bidders
    c. Proposals
    d. Agreements
    e. Performance bonds

Student Performance Objective 2:

Given various codes relating to wastewater treatment systems, the student will read and interpret the codes verbally or in writing so well that the interpretations of the codes meet the approval of the instructor.

Instructional Areas:

1. Identifying the purpose of codes relating to a wastewater treatment system
    a. Protecting health of people
    b. Providing safety for workers
    c. Maintaining welfare of people
2. Identifying the types of building codes pertinent to a wastewater treatment system and their uses
    a. National codes
    b. Uniform building codes
    c. Basic building codes
    e. National electrical codes
    f. National plumbing codes
    g. Local building codes and general restrictions
        (1) Zoning
        (2) Dimensions
        (3) Encroachment
        (4) Occupancy
3. Determining building code requirements
    a. Lighting and ventilation
        (1) Windows
        (2) Skylights
        (3) Mechanical equipment
    b. Exits
        (1) Stairways
        (2) Ramps
        (3) Halls

   - (4) Doorways
   - (5) Other types of exits

c. Types of constructions and materials

   - (1) Fireproof
   - (2) Semifireproof
   - (3) Heavy timber
   - (4) Wood frame
   - (5) Metal

d. Materials and design loads

   - (1) Materials
   - (2) Tests
   - (3) Live loads
   - (4) Wind loads

e. Construction requirements

   - (1) Working stresses
   - (2) Bearing values
   - (3) Drainage
   - (4) Fire partition

f. Chimneys, flues, and vents

   - (1) Metal
   - (2) Cupola Chimneys
   - (3) Gas vents and flues

g. Construction safeguards and sanitation requirements

   - (1) Scaffolds
   - (2) Hoists
   - (3) Lights
   - (4) Sanitation

Examples of Supporting References: Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and students may invite the local building inspector to class and have the inspector discuss the purposes of building codes and other factors pertinent to building construction requirements.

2. Given the task of interpreting the national plumbing code, the instructor may have several students visit

a master plumber and interview him on the essential aspects of the national plumbing code.

3. Given the task of determining the building code requirements for ventilation of specified chlorine buildings, the instructor may give two students a copy of state building codes related to wastewater treatment systems and have the students determine the code requirements for ventilation of chlorine buildings and report to the class their findings.

Examples of Evaluation Techniques:

1. The student should be able to list at least two purposes for building codes relating to wastewater treatment systems.

2. The student should be able to read a local building code and explain to the satisfaction of the instructor the requirements concerning fireproofing buildings.

Instructional Resources:

1. Access to a local building inspector

2. Copies of the following building codes:

   a. National Code
   b. Uniform building code
   c. Basic building code
   d. State building code
   e. National electrical code
   f. National plumbing code
   g. Local building codes

Student Performance Objective 3:

Given various sets of water pollution standards, the student will be able to read and interpret the standards verbally or in writing so well that the interpretations of the water pollution standards meet the approval of the instructor.

Instructional Areas:

1. Determining governmental water pollution standards

   a. State standards
   b. Federal standards

      (1) Water Pollution Control Act Amendments of 1972
      (2) National Pollution Discharge Elimination System

   c. Local standards

2. Identifying the types of tests used in setting water pollution standards
   - a. Biochemical Oxygen Demand
   - b. Suspended solids
   - c. Fecal coliform bacteria
   - d. pH

3. Interpreting test results used in setting water pollution standards
   - a. Considering milligrams per liter in biochemical oxygen demand test for a given period of days
   - b. Considering milligrams per liter in suspended solids test
   - c. Considering number per 100 milliliters fecal coliform bacteria count
   - d. Considering pH range

Examples of Supporting References:

Supporting References were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given the task of determining the state water pollution standards wastewater treatment systems must meet, the instructor may ask three students to form a committee and visit the state water and wastewater office to determine and report to the class concerning the standards the state requires for discharging effluent into rivers and streams.

2. Given national standards of water pollution control, the instructor may ask two students to test a sample of wastewater for pH and report to the class the range permissable by national standards and whether their test was within that range.

Examples of Evaluation Techniques:

1. The student should be able to list and interpret the Biochemical Oxygen Demand standards required by Federal Government to the satisfaction of the instructor.

2. The student should be able to list and explain the use of at least three test results that are used in determining water pollution standards.

Instructional Resources:

1. Copies of state and federal water pollution standards
2. Sampling equipment
3. Protective clothing
4. Litmus paper for pH readings

MODULE OF INSTRUCTION

CODE--01.99

DETERMINING CHARACTERISTICS OF WASTEWATER

Module Concept: Wastewater which comes from domestic, and industrial sources must be treated properly before released in rivers, streams and lakes. An understanding of the characteristics of wastewater will assist wastewater treatment personnel in adequately treating wastewater.

The purpose of this module is to depict for the instructor information which should be taught regarding the various characteristics of wastewater. This information should assist the student in understanding the process of wastewater treatment.

Prerequisites: Admission to the Environmental Technology program is sufficient evidence of qualifications for entry into the course. Courses in biology and chemistry would be helpful.

Module Goal: When this module is completed, the student should be able to explain and measure the characteristics of wastewater.

Student Performance Objective 1: Given various samples of wastewater to be measured, the student will accurately measure the samples for their physical characteristics, 95% of the samples should be measured for physical characteristics according to given directions.

Instructional Areas:

1. Identifying the physical characteristics of wastewater
    - a. Temperature
    - b. Odor
    - c. Color
    - d. Turbidity
    - e. Variation in flow
2. Determining the effects of temperature in waste
    - a. Sedimentation
    - b. Biological activity

3. Measuring temperature in waste

   a. Selecting the appropriate thermometer
   b. Selecting the place and time of measurement

4. Detecting odors in wastewater

   a. Musty
   b. Rotten egg odor
   c. Unusual odors

5. Measuring odors

   a. Identifying threshold odor
   b. Following appropriate procedures

6. Determining color of wastewater

   a. Grayish
   b. Black
   c. Other colors

7. Determining amount of turbidity using

   a. Turbidimeter
   b. Jackson Candle

8. Determining causes of flow variation

   a. Size of community
   b. Industrial users
   c. Differing systems

9. Measuring flow variation (The instructor may desire to refer to Collecting and Transporting Wastewater to Designated Site for details on measuring flow).

Examples of Supporting References:

1. Operation of Wastewater Treatment Plants. Water Pollution Control Federation. WPCF Manual of Practice No. 11. Washington, D.C. pp. 5-9.

2. Manual of Instruction for Sewage Plant Operators. Health Education Service. P.O. Box 7283 Albany, N.Y. 12224.

3. Wastewater Treatment Operator Training Course Two. Water Pollution Control Federation. WPCF Publication No. 14. Washington, D.C. 1967.

Examples of Student Learning Activities:

1. The student may demonstrate the use of the turbidimeter by measuring turbidity.
2. Given two samples of water containing equal amounts of organic matter and a thermometer, the instructor may ask several students to heat one sample to 105° F and cool the second sample in the refrigerator to 45° F and record the effects of temperature on sedimentation after one hour.
3. The instructor and students may visit a wastewater treatment site and the instructor may have several students follow the appropriate procedures in determining the intensity of odor present.
4. The instructor and students may visit a wastewater treatment site, and the instructor may have several students estimate the flow into the system by using the flow measuring device that is in use at that system.

Examples of Evaluation Techniques:

1. Given three samples of wastewater, the student should be able to identify the odors of at least two samples.
2. Given a sample of wastewater and a thermometer, the student should be able to measure the temperature of the sample within 5 degrees of accuracy.
3. Given a chart of hourly variation of flow of wastewater, the student should be able to describe at least two possible causes for the flow variation.

Instructional Resources:

1. Sampling equipment
2. Several samples of wastewater of varying turbidity
3. Thermometer
4. Turbidimeter
5. Access to a wastewater treatment flow measuring device in operation
6. Charts showing hourly flow variation into a wastewater treatment system
7. Samples of wastewater of varying colors
8. Samples of wastewater of varying odors
9. Procedures for identifying threshold odor

Student Performance Objective 2:

Upon completion of receiving pertinent instruction, the student will explain verbally or in writing chemical characteristics of wastewater and their effects according to information in appropriate reference.

Instructional Areas:

1. Identifying the chemical characteristics of wastewater and their reactions
   - a. Inorganic
   - b. Organic
2. Determining the effects of inorganic constituents in wastewater
   - a. Giving water its' hardness
   - b. Giving water its' mineral content
3. Determining the effects of organic constituents in wastewater
   - a. Causing unpleasant odors
   - b. Causing scum
   - c. Causing oxygen depletion

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may ask several students to take a sample of fresh wastewater and set it aside in a warm room for 2 days after which several students may be asked to describe how the odor of the sample has changed.
2. The instructor and students may visit a wastewater treatment system, and the instructor may ask several students to inspect the grit removal facilities and explain the characteristics of wastewater which is flowing.

Examples of Evaluation Techniques:

1. Given samples of sand and animal fat, the student should be able to classify each as either organic or inorganic.

2. While visiting a wastewater treatment system, the student should be able to point out at least two effects of organic constituents in wastewater.

Instructional Resources:

1. Samples of organic and inorganic materials found in wastewater
2. Access to a wastewater treatment site
3. Sampling equipment and samples of wastewater
4. Storge containers for wastewater

Student Performance Objective 3:

Given access to appropriate equipment, reagents and samples of wastewater, the student will accurately measure 95% of the samples given for the concentrations of solids, BOD, pH and nitrogen.

Instructional Areas:

1. Measuring solids in wastewater with appropriate equipment and reagents
    a. Measuring suspended solids
    b. Measuring settleable solids
    c. Measuring collidal suspended solids
    d. Measuring dissolved solids
    e. Measuring total solids
2. Measuring Biochemical Oxygen Demand (BOD)
    a. Taking the sample
    b. Selecting and using appropriate equipment
    c. Using the appropriate reagents
    d. Following the appropriate procedure
    e. Reading and interpreting results
    f. Performing the necessary calculations
    g. Recording results
3. Measuring pH
    a. Taking the sample
    b. Selecting and using appropriate equipment
    c. Using the appropriate reagents
    d. Following the appropriate procedure
    e. Reading and interpreting results
    f. Recording results

4. Measuring nitrogen in wastewater
    a. Taking the sample
    b. Selecting and using appropriate equipment
    c. Using the appropriate reagents
    d. Following the appropriate procedure
    e. Reading and interpreting results
    f. Recording results

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. While visiting a wastewater treatment system, the instructor may ask several students to collect a sample of water using the appropriate equipment.
2. Given appropriate equipment and solutions, the instructor may ask several students to measure the pH of various samples of water
3. Given a BOD test to run, the instructor may ask a student to assemble the necessary equipment for the BOD test.
4. Given an Imhoff cone, the instructor may ask several students to test a sample of water for settleable solids.
5. Given the depletion of dissolved oxygen, volume of bottle and volume of sample, the instructor may ask several students to calculate the 5-day BOD.

Examples of Evaluation Techniques:

1. The student should be able to wash an Imhoff cone with soap and hot water to the satisfaction of the instructor.
2. Given a Gooch crucible and other appropriate equipment, the student should be able to perform a suspended solids test with 90% accuracy.
3. Given the appropriate equipment and reagents, the student should be able to test a sample of water for pH within .5 of the actual pH.

Instructional Resources:

1. Appropriate equipment and reagents for performing the following tests:
    a. Suspended solids
    b. Settleable solids
    c. Collidal suspended solids
    d. Dissolved solids
    e. Total solids
2. Appropriate equipment and reagents for performing the following tests:
    a. BOD
    b. pH
    c. Nitrogren
3. Sampling equipment and protective clothing
4. Access to a wastewater treatment system
5. Wastewater samples

MODULE OF INSTRUCTION

CODE--01.99

WATER AND WASTEWATER DISEASE TRANSMITTAL

Module Concept: Our streams, rivers, and lakes have been polluted to some degree over the years by domestic and industrial wastes. The pollutants in these waters have created problems to our environment. Persons interested in the health of humans and the field of environmental science, particularly water quality, should be knowledgeable in terms of certain effects highly polluted waters have on humans, fish, wildlife and plants.

Prerequisites: Admission in the Environmental Technology Program is sufficient evidence of qualifications for entry into the course. A relevant concurrent course in basic biology is suggested.

Module Goal: When this module of instruction is completed, the student should be able to explain in terms understandable by the lay public how water and wastewater diseases are transmitted and the effects these diseases have on humans and animals.

Student Performance Objective 1: Given the task of explaining several water and wastewater diseases transmitted by air and their effects, students will explain verbally or in writing the given types of diseases and their effects on humans and animals according to appropriate reference material.

Instructional Areas:

1. Identifying water and wastewater diseases transmitted by air and their life cycles

    a. Colds
    b. Tuberculosis
    c. Influenza

2. Identifying symptoms of diseases transmitted by air that are encountered by humans and/or animals

    a. Weight loss
    b. Swelling of the joints
    c. Breathing problems

   d. Headaches
   e. High fever
   f. Loss of appetite
   g. Coughing
   h. Watery discharges from the nostrils and eyes
   i. Sore throat

3. Determining the after effects of water and wastewater diseases transmitted by air which effects humans and animals

   a. Body condition
   b. Body appearance

Examples of Supporting References:

1. Operation of Wastewater Treatment Plants, Sacramento, California: Sacramento State College, 1970. Chapter 2 covers the basic concept why wastes should be treated. One should also refer to Chapter 2 of this reference in discussing and understanding the remaining student performance objectives in this module. (Copies of this reference may be obtained from Professor Kenneth Kerri, Sacramento State College, 6000 Jay Street, Sacramento, California 95819.)

Examples of Student Learning Activities:

1. The instructor and students may desire to visit a waiting room of the local public health department and observe individuals who have encountered colds or flu. A nurse or doctor could be acquired to explain to students possible causes of colds in a given area and a particular time of the year.

2. The instructor and students could visit a cattle feed lot or a local veterinarian and have several students identify colds and flu symptoms.

Examples of Evaluation Techniques:

1. The instructor may desire to prepare a written examination and ask student to list several symptoms of colds, tuberculosis, and influenza.

2. In the written examination, the instructor may ask students to explain possible affects tuberculosis could have on human bodies.

Instructional
Resources:

1. Filmstrips
2. Films
3. Slides
4. Charts
5. Pamphlets
6. Appropriate Projector

Student
Performance
Objective 2:

Given the task of explaining several water and wastewater diseases transmitted by food, water, solids and their effects, students will explain verbally or in writing the given types of diseases and their effects on humans and and animals according to appropriate reference material.

Instructional
Areas:

1. Identifying water and wastewater diseases transmitted by food, water, and solids
    - a. Typhoid
    - b. Paratyphoid
    - c. Dysentry
    - d. Cholera
2. Identifying symptoms of diseases transmitted by food, water, and solids which are encountered by humans and/or animals
    - a. Weight loss
    - b. Swelling of the joints
    - c. Breathing problems
    - d. Headaches
    - e. High fever
    - f. Loss of appetite
    - g. Coughing
    - h. Watery discharges from the nostrils and eyes
    - i. Sore throat
3. Determining the after effects of water and wastewater diseases transmitted by food, water, and solids which effects humans and animals
    - a. Body condition
    - b. Body appearance

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may ask students to bring to class pictures of humans and/or animals which have been affected by diseases transmitted by food, water, and solids.

2. Several of the students in the class may explain how a given disease transmitted by food, water, and solids affects the body of humans and/or animals.

Examples of Evaluation Techniques:

Similar evaluation techniques could be used as suggested under Student Performance Objective 1.

Instructional Resources:

Similar instructional resources will be needed in completing this Student Performance Objective as depicted in Student Performance Objective 1.

Student Performance Objective 3:

Given the task of explaining several water and wastewater diseases transmitted by insects, animals and their effects, student will explain verbally or in writing the given types of diseases and their effects on humans and animals according to appropriate reference materials

Instructional Areas:

1. Identifying water and wastewater diseases transmitted by insects and animals

    a. Malaria
    b. Yellow Fever
    c. Plague
    d. Brucellosis
    e. Anthrax
    f. Psittacosis
    g. Trichinosis
    h. Bovine Tuberculosis

2. Identifying symptoms of diseases transmitted by insects and animals which affects humans and other animals

3. Determining the after effects of water and wastewater diseases transmitted by insects and animals which affects humans and other animals

    a. Body condition
    b. Body appearance

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and students may invite a veterinarian to come to class and discuss how water and wastewater diseases are transmitted by insects and animals as well as the effects of these diseases on human and animal bodies.

2. The instructor may wish to divide the class into individual groups of about five students and assign a water and wastewater disease transmitted by insects and animals to each group. Each group may determine whether the assigned disease was detected in the local community over the last ten years. If the disease was detected in the local community during the last ten years, the student could then make a report on the methods used to control and eliminate the problem. If the disease was not detected, the students could make a report indicating why such diseases were not a problem in the area.

Examples of Evaluation Techniques:

Similar evaluation techniques could be used as suggested under Student Performance Objective 1.

Instructional Resources:

Similar instructional resources will be needed in completing this Student Performance Objective as shown in Student Performance Objective 1.

MODULE OF INSTRUCTION

CODE--01.99

USING GOOD HOUSEKEEPING TECHNIQUES IN OPERATING WASTEWATER TREATMENT SYSTEMS

Module Concept: Visitors and management are usually impressed by the neat and clean appearance of the grounds, buildings and equipment in wastewater treatment systems. An attractive work site contributes to the morale of the plant personnel. Most importantly, neat and clean plant grounds and equipment contribute greatly to safe working conditions in the system.

The purpose of this module is to depict for the instructor areas which should be taught relative to good housekeeping in wastewater treatment systems so that the student will understand the need for good housekeeping techniques and will be motivated to practice such techniques while working in a wastewater treatment system.

Prerequisites: The module on Using Safety Practices in Operating Wastewater Treatment Systems is suggested before this module of instruction is undertaken.

Module Goal: When this module of instruction is completed, the student will understand the need for good housekeeping techniques in a wastewater treatment system and will be able to apply techniques while working in wastewater treatment systems.

Student Performance Objective 1: Given access to wastewater treatment system buildings, the student will organize equipment, clean and maintain buildings to the satisfaction of the instructor and so that they are attractive and safe for working.

Instructional Areas:

1. Cleaning bar screens and removing trash from areas manually

   a. Selecting equipment for removing trash
   b. Removing material that will cause slippery surfaces
   c. Removing material that will provide a breeding place for insects
   d. Removing unsightly trash

2. Removing oil and grease spills in pumping rooms and around pumps which are located out in the open

   a. Spreading appropriate absorbent materials
   b. Selecting and using brooms and shovels
   c. Putting used absorbent materials in appropriate containers to be destroyed

3. Storing tools and equipment

   a. Determining where to place tools and equipment
   b. Organizing and securing tools and equipment
   c. Keeping in proper place when not using

4. Painting buildings and equipment

   a. Selecting paints and brushes
   b. Selecting mechanical painting equipment
   c. Thinning and mixing paints
   d. Preparing surfaces to be painted
   e. Using appropriate brushes and equipment in painting

5. Storing non-usable materials

   a. Using fireproof containers for oily rags and papers
   b. Emptying frequently

6. Sweeping, washing and waxing floors

   a. Selecting appropriate brooms, mops and waxing equipment
   b. Using correct techniques in sweeping floors
   c. Selecting desired cleaning solutions and using correct techniques in washing floors
   d. Selecting waxing solutions and using correct techniques in waxing floors

7. Dusting and washing furniture and walls

   a. Selecting appropriate cloths and cleaning equipment

   b. Using correct techniques in dusting
   c. Selecting waxing solutions for furniture and using correct techniques in washing furniture and walls
   d. Selecting waxing solutions for furniture and using correct techniques in waxing furniture

8. Identifying the benefits of organizing and cleaning buildings

   a. Prolonging life of structures
   b. Maintaining safe and enjoyable working conditions
   c. Providing attractive buildings for visitors and plant management

Examples of Supporting References:

1. Wastewater Treatment Plant Operator Training Course Two. Water Pollution Control Federation. WPCF Publication No. 14. Washington, D.C. 1967. pp. 131-135.

2. Manual of Instruction for Sewage Treatment Plant Operators. Health Education Service. P.O. Box 7283. Albany, N.Y. 12224. Chapter 13.

3. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970. Chapter 12.

Examples of Student Learning Activities:

1. While working with the wastewater treatment operator in a wastewater treatment system, the operator or instructor may give the student a rake and have the student clean the bar screen at the lift pumping station.

2. Given an oil spill at a pump, the instructor may have two students select the appropriate cleaning solutions and equipment and clean up the spill.

3. Given appropriate paint and equipment, the instructor may have three students prepare a metal pipe for painting and paint the pipe.

4. Given mop, bucket and appropriate cleaning material, the instructor may have three students wash a floor.

5. Given cloth, furniture polish, and dusty furniture the instructor may have two students polish the furniture.

Examples of Evaluation Techniques:

1. Given appropriate materials, the student should be able to clean oil and grease from a floor to the satisfaction of the instructor.

2. While working in the school laboratory, the student should be able to place tools in their appropriate places to the satisfaction of the instructor.

3. Given appropriate materials, the student should be able to prepare and paint a metal surface to the satisfaction of the instructor.

4. Given the task of waxing floors, the student should be able to select the appropriate wax and wax the floor in the office of a wastewater treatment system to the satisfaction of the instructor.

Instructional Resources:

1. Access to a wastewater treatment system
2. Access to a workshop area
3. Rake for cleaning bar screens
4. Cleaning materials and equipment for cleaning up oil and grease
5. Paint, paint brushes, and painting equipment
6. Paint scrapping equipment
7. Bucket, mop and cleaning materials
8. Dusting and polishing cloths
9. Wax for floors
10. Access to an office

Student Performance Objective 2:

Given access to wastewater treatment system grounds which surround buildings, equipment and lagoons, the student will clean and maintain the grounds to the satisfaction of the instructor and so that they are attractive and safe for working.

Instructional Areas:

1. Removing ice and snow from parking areas, roads and walks

- a. Selecting the appropriate equipment and tools
- b. Selecting the appropriate materials
- c. Operating the equipment in a safe manner

2. Maintaining roads

   - a. Determining conditions and what must be done for improvement
   - b. Selecting and using equipment for grading and leveling roads

3. Establishing and maintaining lawns

   - a. Taking a soil sample to determine soil needs
   - b. Selecting proper seed for soil and climate
   - c. Selecting and using proper tools and equipment in preparing the ground for seeding
   - d. Selecting and using proper tools and equipment in seeding the lawn
   - e. Cutting with appropriate equipment
   - f. Selecting and using appropriate equipment for applying fertilizer as required

4. Planting and caring for trees and shrubs

   - a. Planting trees and shrubs

     - (1) Determining the type and number of trees and shrubs needed
     - (2) Selecting and using desired tools and equipment
     - (3) Applying compost and fertilizers
     - (4) Setting in and planting trees and shrubs
     - (5) Watering until roots are well established

   - b. Planting and caring for trees and shrubs

     - (1) Keeping deciduous trees away from sewers
     - (2) Keeping deep rooted trees away from sewers

   - c. Trimming shrubs

     - (1) Selecting the appropriate equipment
     - (2) Trimming
     - (3) Hauling away the trimmings

5. Establishing and caring for flowers

   - a. Determining the type and number of flower needed and tools

b. Selecting and using desired equipment in preparing the seed bed

c. Selecting and using desired equipment in planting seeds and plants

d. Selecting and using desired equipment in applying fertilizer

e. Caring for the flowers

   (1) Weeding with appropriate tools
   (2) Watering as required

Examples of Supporting References: Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. After a heavy snowfall, the instructor may ask several students to operate a snow plow on the front of a pick-up truck in cleaning a parking lot of snow.

2. The instructor and students may visit a gravel road in need of grading. and the instructor may ask several students to explain what they would do to put the road in a satisfactory condition.

3. Given an area to be seeded with grass, the instructor may ask several students to prepare the soil with the appropriate equipment for seeding.

4. The instructor may ask several students to cut the lawn using power operated grass cutting equipment.

5. Given a potted perennial flower, the instructor may ask a student to prepare the flower bed and plant the flower out-of-doors in an appropriate location.

6. The instructor may ask several students to take a soil sample and send it to the appropriate agency for a soil analysis.

7. Given hand operated trimming equipment, the instructor may ask several student to trim a brush.

Examples of Evaluation Techniques:

1. Given the task of removing snow with a pick-up truck with an attached snow plow, the student should be able to operate the equipment by removing snow in a parking lot to the satisfaction of the instructor.

2. Given an area where seeds are to be planted and appropriate equipment, the student should be able to prepare an area for planting seeds to the satisfaction of the instructor.

3. Given plants to be transplanted out-of-doors and appropriate equipment, the student should be able to transplant a potted plant out-of-doors to the satisfaction of the instructor.

4. Using power operated mowing equipment, the student should be able to mow a lawn to the satisfaction of the instructor.

5. Given a hedge to be trimmed with appropriate equipment, the student should be able to trim the hedge to the satisfaction of the instructor.

6. Using appropriate weeding equipment, the student should be able to remove weeds from a flower bed without damaging the flowers.

Instructional Resources:

1. Access to a pick-up truck with a snow plow attachment
2. Access to an ungraded gravel road
3. Equipment for preparing a lawn for seeding

   a. Shovel
   b. Rake
   c. Hoe

4. Access to a lawn to mow and powered mowing equipment
5. Potted perennial flower
6. Flower bed in which to transplant potted flowers
7. Equipment for trimming hedges
8. Equipment for weeding a flower bed
9. Access to a hedge that requires trimming

MODULE OF INSTRUCTION

CODE--01.99

USING APPLIED MATHEMATICS IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS

Module Concept: Mathematics is required in many processes which occur in wastewater treatment systems. Personnel working in wastewater treatment systems must be capable of applying basic mathematical skills in performing calculations related to plant operations.

This module has been developed to assist the instructor in identifying instructional areas which should be taught so that the student will be capable of performing basic mathematical skills while working in wastewater treatment systems.

Prerequisities: Basic courses in High School mathematics would be helpful to the student.

Module Goal: When this module of instruction is completed, the student will be able to solve problems involving applied mathematics in a wastewater treatment system.

Student Performance Objective 1: Given areas to be calculated and materials for making calculations, the students will accurately calculate 95% of the areas given.

Instructional Areas:

1. Identifying basic units in the English system used in making calculations in wastewater treatment systems and their uses:
   a. Inch
   b. Foot
   c. Yard
   d. Mile
2. Identifying basic units in the metric system used in performing calculations in wastewater treatment systems and their uses:
   a. Centimeter
   b. Meter
   c. Kilometer

3. Calculating areas of various shapes of pipes, lagoons and filters
    a. Applying addition, multiplication and division in measuring *rectangular* shapes
    b. Applying addition, multiplication and division in measuring *square* shapes
    c. Applying multiplication, division and the use of fractions in measuring *triangular* shapes
    d. Applying multiplication, division and the use of square roots and pi in measuring *circular* shapes
    e. Applying addition, multiplication, division and pi in measuring *cylindrical* shapes
    f. Applying multiplication, division, square roots and addition in measuring *conical* shapes
    g. Applying multiplication and the use of pi and square roots in measuring *spherical* shapes

Examples of Supporting References:

1. Kerri, Kenneth D. *Operation of Wastewater Treatment Plants*. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970. Chapter 15.

2. *Course in Applied Mathematics for Water and Wastewater Personnel*. Michigan Department of Public Health: Lansing, Michigan. 1968.

Examples of Student Learning Activities:

1. The instructor may have students work problems similar to the ones listed below:

    a. *A problem in measuring rectangular shapes:* Given a rectangular lagoon 134 feet long and 68 feet wide, what is the area of the lagoon?

       The formula for determining area of rectangles is:
       Area = length x width
       Solution: 134 X 68 = 9112 square feet

    b. *A problem in measuring triangular shapes:* Given a field in the shape of triangle with sides of 30, 50 and 40 feet, what is the area of the field?

       The formula for determining area of a triangle is:
       Area = ½ x the length of base x the height
       Solution: ½ x 30 x 40 = 60 square feet

c. A problem in measuring circular shapes:
Given the bottom of a round storage tank with a diameter of 20 feet, what is the area of the bottom?

The formula for determining the area of a circle is:
Area = pi x radius squared
Solution: 3.14 x 10 x 10 = 314 square feet

d. A problem in measuring cylindrical shapes:
Given 200 feet of 6 inch pipe and protective coating to apply, which the manufacturer recommends applying at the rate of 1 quart to per 100 square feet, what is the amount of protective coating required to cover to pipe?

The formula for determining circumference is:
Circumference = pi x diameter
Solution: 3.14 x ½ foot = 1.57 feet

The formula for determining the area is:
Area = circumference x length
Solution: 1.57 x 200 = 314 square feet
Answer - 100 square feet divided into 314 square feet = 3.14 quarts of protective coating

Examples of Evaluation Techniques:

1. Given a total of 10 similar problems shown in student learning activities, the student should be able to calculate at least nine of the problems correctly.

Instructional Resources:

1. Actual data from a wastewater treatment plant for students to use in calculations.

Student Performance Objective 2:

Given volumes to be calculated and materials for making calculations, the student will accurately calculate 95% of the volumes given.

Instructional Areas:

1. Identifying types of volume measurements

   a. Space occupied by a solid figure
   b. Units of volume in cubics

      (1) Cubic inches
      (2) Cubic feet
      (3) Cubic yards
      (4) Gallons

2. Calculating volumes of various shapes of pipes, lagoons, basins and tanks

   a. Applying division, multiplication and fractions in calculating volume of rectangular shapes
   b. Applying division, multiplication and using fractions in calculating the volume of a prism
   c. Applying multiplication and the use of squares in calculating the volume of cylindrical shapes.
   d. Applying multiplication, and the use of pi, fractions and squares in calculating the volume of conical shapes
   e. Applying multiplication, and using pi, fractions and squares in calculating the volume of spherical shapes

3. Calculating weight-volume relationships

   a. Determining the weight of a gallon of water
   b. Determining the weight of a cubic foot of water
   c. Using multiplication, division and use of fractions in calculating weight-volume relationships

      (1) Considering pounds per cubic foot
      (2) Considering pounds per gallon

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may ask several students to use a one cup measuring device and count the number of cups needed to fill a one gallon liquid container.

2. The instructor may ask two students to fill a one foot cube with water and measure the number of gallons of water per cubic foot.

3. The instructor may ask several students to measure the diameter of a pipe with an appropriate rule.

4. The instructor may ask several students to measure with appropriate measuring devices, the depth, length and width of a storage lagoon.

Examples of Evaluation Techniques:

1. Given access to a lagoon in a wastewater treatment system the student should be able to measure the

lagoon depth, width and length and using the figures obtained, calculate the number of gallons of water it will hold at the maximum level with 90% accuracy.

2. Given the task of calculating cubic yards, the student should be able to calculate the number of cubic yards of soil that must be removed to build a storage lagoon 100 feet square and 5 feet deep.
3. Given a ruler and a pipe, the student should be able to measure the diameter and length of the pipe with 100% accuracy.

Instructional Resources:

1. Access to a wastewater treatment system
2. Actual data from a wastewater treatment system for student to use in calculations
3. Measuring cups
4. Pipes with different diameters and lengths
5. Rule for measuring
6. Gallon containers

Student Performance Objective 3:

Given the task of calculating velocity and rate of flow, the student will accurately calculate 95% of the velocity and rate of flow mathematical problems given.

Instructional Areas:

1. Calculating velocity of wastewater in channels, pipes and other conduits
    a. Applying multiplication and division in calculating velocity of flow
    b. Determining velocity of flow
        (1) Considering distance
        (2) Considering time
2. Calculating the rate of flow of wastewater in channels, pipes and other conduits
    a. Applying multiplication, division and the use of fractions in calculating rate of flow
    b. Determining rate of flow
        (1) Considering time
        (2) Considering distance

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. While visiting a wastewater treatment system, the instructor may have students explain the operation of common measuring device used to measure the flow rate of wastewater.

2. The instructor may have several students construct a small scale Parshall flume that could be used to measure the flow of tap water.

3. The instructor may secure a venturi meter, and ask several students to explain the operation of the meter in measuring wastewater flow.

Examples of Evaluation Techniques

1. Provided information regarding the size of the channel and the velocity of the water in feet per second, the student should be able to determine accurately the rate of flow in cubic feet per second with 95% accuracy

2. The student should be able to identify and explain to the satisfaction of the instructor the operation of at least two of the three types of common measuring devices used in measuring flow in a wastewater treatment system.

Instructional Resources:

1. Access to a wastewater treatment system operational measuring device
2. Materials to construct a Parshall flume

    a. A 10 foot long sheet of flexible metal 1 foot wide
    b. Wood for constructing a Parshall flume
    c. Caulking materials and equipment
    d. Hammer and nails
    e. Saw

3. Models of Parshall flumes, weirs and Venturi meters

Student Performance Objective 4:

Given the task of calculating weight relationships, the student will calculate 95% of the weight relationships given.

Instructional Areas:

1. Identifying terms in measuring weight relationships (parts per million units of measurement) and their uses by considering:
   a. Pounds
   b. Grams or milligrams
   c. Liter or milliliters
2. Calculating weight relationships
   a. Applying multiplication, division and the use of fractions in calculating weight relationships
   b. Applying multiplication, division and the use of fractions in calculating chemical dosages and rates of feed

Examples of Supporting References:

Supporting References were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may ask several students to jar test a wastewater sample to determine the parts per million of chlorine required to produce a 1 part per million residual after 15 minutes contact.
2. The instructor may ask several students to weigh out one gram of sand on a balance.

Examples of Evaluation Techniques:

1. The student should be able to visit a wastewater treatment chlorination system and, by reviewing the records, calculate that amount of chlorine in parts per million that was used on the previous day in treating the wastewater with 95% accuracy.
2. Given the appropriate type of scale, the student should be able to weigh out one pound of sand on the balance with complete accuracy.

Instructional Resources:

1. Access to records of a wastewater treatment chlorination system
2. Balance
3. A bucket of sand

4. Appropriate equipment for jar testing for chlorine residual
5. Sample of wastewater

Student Performance Objective 5:

Given accurate information regarding wastewater treatment systems and a given number of efficiency problems to be calculated, the student will accurately calculate 95% of the plant efficiency problems given.

Instructional Areas:

1. Determining efficiency
    a. Determining units to be used in calculating
        (1) Horsepower
        (2) Milligrams
        (3) Pounds
    b. Considering output
    c. Considering input
2. Calculating efficiency of wastewater treatment plant operations (e.g. pumps, aerator cells, lagoons, settling basins, chlorinators) by using the following mathematical skills:
    a. Using formula for calculating efficiency
    b. Fractions
    c. Division
    d. Multiplication
    e. Use of percentages
    f. Ratio and proportions
    g. Using decimals
    h. Addition
    i. Subtraction

Examples of Supporting References:

Supporting References were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may ask two students to take samples of wastewater influent flowing to aerator and effluent flowing from the aerator to determine the amount of BOD in each sample, then take the results of the two samples and calculate the efficiency of the aerator in decreasing BOD.

2. The instructor may ask several students to read a motor nameplate and determine the horsepower of the motor.

3. The instructor may ask three students to use a pressure gauge in measuring the pressure against which a pump is operating.

Examples of Evaluation Techniques:

1. The student should be able to take a sample of wastewater and measure it for BOD according to required procedures.

2. Given a pressure gauge, the student should be able to measure the amount of pressure in a given water line with 95% accuracy.

3. Given access to a flowmeter, the student should be able to determine the number of gallons per minute that a given pump is pumping with 95% accuracy.

Instructional Resources:

1. Sampling Equipment
2. Access to a wastewater treatment system aerator
3. Appropriate equipment for measurement of BOD
4. A sample motor
5. Pressure gauge
6. Flowmeter
7. Operational motor and pump

Student Performance Objective 6:

Given the task of calculating basic mathematical problems the student will convert measurements of the English system to the Metric system and calculate 95% of the mathematical problems given.

Instructional Areas:

1. Understanding terminology used in the Metric System

   a. Milli
   b. Centi
   c. Deci
   d. Unit
   e. Deka
   f. Hecto
   g. Kilo

2. Converting the English system to the Metric system by considering:

   a. Inches
   b. Feet
   c. Miles

3. Calculating length using the Metric system by considering:

   a. Kilometers
   b. Meters
   c. Centimeters
   d. Millimeters

4. Calculating capacity using the Metric system by considering:

   a. Cubic meters
   b. Kiloliters
   c. Liters
   d. Milliliters

5. Calculating weight using the Metric system by considering:

   a. Kilograms
   b. Grams
   c. Milligrams
   d. Micrograms

6. Determining temperature in centigrade and Fahrenheit scales

   a. Converting Fahrenheit to centigrade
   b. Converting centigrade to Fahrenheit

Examples of Supporting References: Examples of Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may give the student a Metric ruler of one meter and an English system ruler of one yard and have the student determine the metric measurement at 6 inches.

2. The instructor may have a student measure a string three feet in length with an English system ruler.
3. The instructor may have three students weigh one gallon of water using a quart container.
4. The instructor may have several students weigh a kilogram of sand using a Metric scale.
5. The instructor may have two students take the temperature of a glass of water in centigrade degrees.

Examples of Evaluation Techniques:

1. The student should be able to measure a board using a Metric ruler with 95% accuracy.
2. The student should be able to convert miles to kilometers with 95% accuracy.
3. Given a scale that weighs in grams, the student should be able to weigh a pencil with 95% accuracy.
4. Given a centigrade thermometer, the student should be able to measure a sample of water with 95% accuracy.

Instructional Resouces:

1. Metric rulers of one meter and .305 meter
2. Quart and gallon measuring containers
3. Balance capable of measuring in grams and kilograms
4. Balance capable of measuring in pounds and ounces
5. Samples of sand and water to be weighed and measured
6. Centigrade thermometer
7. Fahrenheit thermometer

Student Performance Objective 7:

Given accurate information and basic mathematical problems related to wastewater treatment systems, the student will use steps necessary in accurately solving 95% of the mathematical problems given.

Instructional Areas:

1. Solving mathematical problems
    a. Identifying the problem to be solved such as:
        (1) Finding the volume in a storage lagoon

    - (2) Finding the efficiency of operation of a wastewater treatment operation

  - b. Selecting appropriate formulas such as:
    - (1) Formula for calculating the volume of a cylinder
    - (2) Formula for converting Fahrenheit to centigrade

  - c. Determining the appropriate units and dimensional analysis (e.g. if one is calculating feet, all other given units must be calculated in feet) such as:
    - (1) When calculating in feet, all inches must be converted to fractions or decimals of feet.
    - (2) When calculating in gallons, all cubic feet volumes must be converted to gallons

2. Making calculations using the appropriate mathematical skills such as:
   - a. Adding
   - b. Subtracting
   - c. Multiplying
   - d. Dividing
   - e. Using fractions and decimals
   - f. Using squares, cubes and roots

3. Checking the results
   - a. Examining calculations and answer
   - b. Checking with other appropriate persons regarding the answers

Examples of Supporting References:

Examples of supporting references were discussed in Student Performance Objective 1. In addition the following may be helpful:

1. Manual of Instruction for Sewage Treatment Plant Operators. Health Education Service. P.O. Box 7283. Albany, New York, 12224. pp. 183-190 and 215-219.

2. Manual of Wastewater Operations. Texas Water Utilities Association. Texas State Department of Health. Austin, Texas. 1971.

3. Mathematics for Operators of Water Pollution Control Plants.
   Obtain from Secretary-Treasurer, California Water Pollution Control Association, P.O. Box 61, Lemon Grove, California. 92045.

Examples of Student Learning Activities:

1. The instructor may have several students determine the temperature of a tap water sample in degrees Fahrenheit and convert into degrees centigrade.

2. The instructor and students may visit a chlorination system and the instructor may ask several students to examine the records and calculate the chlorine feed rate for that day.

Examples of Evaluation Techniques:

1. Given a sample of tap water, the student should be able to measure the temperature of the water sample in degrees Fahrenheit and convert to degrees centigrade with 95% accuracy.

2. Given a mathematical problem that has been solved regarding efficiency of a treatment process, the student should be able to demonstrate how to check the answer for accuracy.

Instructional Resources:

1. Access to a wastewater treatment system
2. Access to the daily records of a chlorination system
3. Measuring equipment
4. Samples of tap water
5. Fahrenheit thermometer
6. Centigrade thermometer

APPLYING BASIC CHEMISTRY IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS

CODE--01.99

Module Concept: The wastewater treatment operator and the laboratory technician must deal with basic chemistry in their operations. Basic chemistry is necessary in order to perform the various tests used to control the wastewater treatment process and measure the effectiveness of the treatment.

The purpose of this module is to depict for the instructor areas which should be taught relative to basic chemistry to enable the student to effectively use basic chemistry in wastewater treatment operations.

Prerequisites: Admission to an Environmental Technology program is sufficient evidence of qualifications for entry into the course. Relevant courses in biology and chemistry are suggested.

Module Goal: At the completion of this module, the student will be able to apply basic chemistry in solving problems in a wastewater treatment system in such a way that the student shall be able to work alone in performing the necessary tests, mixing chemicals to produce products and make the necessary calculations.

Student Performance Objective 1: Given the task of identifying symbols and formulas of chemicals used in wastewater treatment systems, the student will identify the symbols and formulas with the elements and compounds they represent verbally or in writing with 95% accuracy.

Instructional Areas:

1. Identifying the symbols of the most common elements of importance in wastewater plants such as:

a.	Aluminum	Al
b.	Calcium	Ca
c.	Carbon	C
d.	Chlorine	Cl
e.	Copper	Cu
f.	Hydrogen	H
g.	Iodine	I
h.	Iron	Fe

i.	Magnesium	Mg
j.	Manganese	Mn
k.	Nitrogen	N
l.	Oxygen	O
m.	Potassium	K
n.	Sodium	Na
o.	Sulfur	S

2. Identifying the symbols of the most common radicals of importance in wastewater treatment plants such as:

a.	Hydroxyl	OH^-
b.	Nitrite	NO_2^-
c.	Nitrate	NO_3^-
d.	Sulfate	SO_4^{-2}
e.	Carbonate	CO_3^{-2}
f.	Hydrogen Carbonate	HCO_3^-
g.	Phosphate	PO_4^{-3}
h.	Silicate	SiO_3^{-2}
i.	Ammonium	NH_4^+

3. Identifying the symbols of the most common formula of importance in wastewater treatment plants such as:

a.	Ammonia	NH_3
b.	Ammonium Hydroxide	NH_4OH
c.	Aluminum Sulfate	$Al_2(SO_4) \cdot 14H_2O$
d.	Calcium Carbonate	$Ca\ CO_3$
e.	Calcium Bicarbonate	$Ca\ (HCO_3)_2$
f.	Calcium Hydroxide	$Ca\ (OH)_2$
g.	Calcium Oxide	CaO
h.	Chlorine	Cl_2
i.	Chlorine Dioxide	ClO_2

Examples of Supporting References:

1. Manual of Instruction for Sewage Treatment Plant Operators. Health Education Service, P.O. Box 7283, Albany, New York, 12224

Examples of Student Learning Activities:

1. Given flash cards, the instructor may have students pair off and practice identifying symbols and formulas of elements and compounds used in wastewater treatment systems.

2. Given the chemical formula for Aluminum Sulfate, the instructor may ask one student to explain to the class the use of the parenthesis in the formula $Al_2(SO_4)_3$.

Examples of Evaluation Techniques:

1. Given the element H and Cl, the student should be able to diagram the result of combining the appropriate amount of each with complete accuracy. Answer: ($H_2 + Cl_2 = 2HCl$)

2. Given the chemical formula NH_3, the student should be able to correctly identify the two elements that make up the formula.

3. Given reactions involved in the treatment of wastewater, the student should be able to calculate the correct number of significant figures, the amounts of reactants necessary for desired reaction.

Instructional Resources:

1. Charts of common elements and formulae and their symbols
2. Chemicals used in wastewater treatment systems
3. Appropriate reaction containers

Student Performance Objective 2:

Given equations of chemical reactions used in wastewater treatment systems, the student will calculate the amounts of reactants needed to produce the desired amounts of products to the correct number of significant figures as determined by the given data.

Instructional Areas:

1. Writing balanced chemical equations

2. Using equilibrium concepts as they apply to wastewater treatment chemistry.

3. Calculating amounts of given reactants to produce required products.

Examples of Supporting References:

In addition to supporting references discussed in Student Performance Objective 1, the following may be helpful:

1. Bailar, John C., Jr., Moeller, Therald and Kleinberg, Jacob. University Chemistry. Boston: D.C. Heath and Company. 1965

2. Basic Chemistry for Water and Wastewater Personnel. Lansing, Michigan: Michigan Section American Water Works Association and Michigan Water Pollution Control Association. 1969.

Examples of Student Learning Activities:

1. Given the element aluminum and diluted hydrochloric acid, the instructor may ask several students to

demonstrate the use of valence in balancing the equation, showing the reaction between the two elements.

2. Given the elements iron and oxygen, the instructor may have several students demonstrate with a formula what chemical reaction occurs when iron rusts.
3. Given chemical materials involved in the treatment of wastewater, the student might calculate the amounts necessary for the desired reaction, combine the chemical and observe the reaction.

Examples of Evaluation Techniques:

1. Given the reaction of aluminum and dilute hydrochloric acid, the student should be able to correctly write the balanced equation.
   Answer: $2Al = 6\ HCL \rightarrow 2AlCl_3 + 3H_2 \uparrow$
2. Given a chart of molecular weights, the student should be able to correctly calculate the molecular weight of sulphuric acid ($H_2\ SO_4$).
   Answer: 98.08
3. Given the reactions involved in the treatment of wastewater, the student should be able to calculate the amounts of reactants for the given reaction to the correct number of significant figures.

Instructional Resources:

1. Chart of molecular weight
2. Chemicals used in the treatment of wastewater
3. Appropriate reaction containers

Student Performance Objective 3:

Given chemical reactions of acids and bases as they relate to the treatment of wastewater, the student will calculate the amounts of acid (base) necessary to neutralize the bases and acids to the correct number of significant as determined by the given concentration of acid (base) and the apparatus appropriate for the determination in wastewater treatment.

Instructional Areas:

1. Determining the characteristics of acids
   a. Ionizes in water to produce positively charged hydrogen ions
   b. Noting differing number of hydrogen ions produced by one molecule of acid

2. Determining the characteristics of bases

   a. Ionizes in water to furnish hydroxyl ions
   b. Differing number of hydroxyl ions are produced by one molecule of base

3. Determining equivalents and pH

   a. In acids weight of acid which will furnish one molecular weight in grams of hydrogen ion.
   b. In salts the molecular weight divided by the number of charges on the ions produced in solution
   c. Expressing pH

4. Neutralization of bases and acids

   a. One equivalent of acid will neutralize one equivalent of base

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1 and 2.

Examples of Student Learning Activities:

1. Given several unknown solutions and litmus paper, the instructor may ask several students to determine whether the solutions are acid or base.

2. The instructor may ask one student to explain to the class what a strong acid is.

3. The students might do an acid-base titration, after having calculated the amount of acid necessary to neutralize the base, given the concentrations of each.

Examples of Evaluation Techniques:

1. Given a solution of sulfuric acid containing 2 mg. H_2SO_4 in each ml., the student should be able to correctly calculate amount of acid required to neutralize 100 ml. of the solution containing 11.5 mg. $CaCO_3$.
   Answer: 5.6 ml.

2. Given appropriate equipment, indicator, HCl of known concentration and base of unknown concentration, the student will do the titration and calculation to determine the concentration of the base.

Instructional Resources:

1. Hydrochloric acid, known concentration
2. Base, unknown concentration
3. Appropriate beakers
4. Tubing
5. Litmus paper
6. Samples of solutions
7. Buret
8. Pipet

Student Performance Objective 4:

Given a range of pH to be investigated in an acid base titration, the student will pick an appropriate indicator as determined by accepted chemical practice.

Instructional Areas:

1. Understanding neutralization
    a. Generally producing a salt and water
    b. Using a type equation
2. Understanding end point
    a. Completeness of neutralization
    b. Using standard solutions
3. Titrating
    a. Determining suitable indicator
    b. Accurately measuring volume of solution

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 2.

Examples of Student Learning Activities:

1. Given a chart of molecular weights for the elements, the instructor may ask several students to determine the molecular weight for H_2SO_4.
2. Given an unknown solution and a range of indicator papers, the instructor may ask several students to screen the sample to find its approximate pH value.

Examples of Evaluation Techniques:

1. Given the need to use colorimetric determinations of pH, the student should be able to explain at least three factors which affect colorimetric determinations.

2. Given the appropriate equipment and measuring devices, the student should be able to measure out exactly 5 mls. of a solution.

3. Given a group of pH ranges and a table of indicators, the student should be able to match appropriate indicators with the correct pH ranges.

Instructional Resources:

1. Burette
2. Flask
3. Volumetric pipette
4. Graduated cylinder
5. Range of PH indicator papers
6. Samples of several solutions
7. Samples of colorimetric indicators
8. Table of various indicators with their pH range

MODULE OF INSTRUCTION

CODE--01.99

COLLECTING AND TRANSPORTING WASTEWATER TO DESIGNATED SITE

Module Concept: Collecting and transporting wastewater is done through a network of pipes and the use of pumps. The amount of wastewater pumped, the distance it is pumped and fluctuating flows can affect the treatment efficiency. It is also important to understand the collecting and transporting system so that the wastewater treatment personnel may locate problems in the collecting and transporting of wastewater.

The purpose of this module is to show the instructional areas which should be covered by the instructor regarding the collecting and transportation of wastewater so that the student will be capable of operating a wastewater collection and transportation system.

Prerequisites: The module on safety practices in wastewater treatment systems should be covered before this module of study is undertaken.

Module Goal: At the completion of this module, the student should be able to explain in terms a layperson can understand the operation of the wastewater treatment collection and transportation system.

Student Performance Objective 1: Given blue prints of a sewer system, the student will interpret and explain verbally the sewer designs and construction according to terminology used in interpreting sewer design and construction.

Instructional Areas:

1. Reading blue prints
    - a. Determining the scale used
    - b. Interpreting lettering used
    - c. Interpreting lines
    - d. Reading dimensions
    - e. Interpreting symbols
2. Interpreting sewer design

a. Determining sewer lines construction requirements

(1) Sufficient slope of mains
(2) Proper bedding
(3) Size and capacity
(4) Manholes and cleanouts
(5) Inverted siphons
(6) Trench loads
(7) Materials inspection
(8) Trenching
(9) Jointing
(10) Backfill
(11) Protecting public water supplies
(12) Preventing hydrogen sulfide gas production

b. Considering important factors in designing sewer lines

(1) Topography
(2) Geology
(3) Infiltration
(4) Character of the sewage; sanitary, storm or combined
(5) Areas to be served, both present and future
(6) Population densities and industry

3. Identifying construction materials and their characteristics

a. Vitrified clay pipe
b. Precast concrete pipe
c. Monolithic concrete
d. Cast iron pipe
e. Steel pipe
f. Asbestos-cement pipe

Examples of Supporting References:

1. Manual of Wastewater Operators. The Texas Water Utilities Association. Texas State Department of Health. Austin, Texas. 1971

2. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970.

Examples of Student Learning Activities:

1. Given a set of blue prints of a sewer system, the student should determine the slope of the mains by observing the blue print.
2. Given an area to be served of 5,000 persons, the student should be able to calculate the size and capacity of the sewer lines needed for serving the community.
3. The instructor and students may visit a sewer site and have several students identify various construction materials that were used in building the system.
4. Given two sewer pipes to join, the instructor may ask several students to describe at least two ways to effectively join the two pipes.

Examples of Evaluation Techniques:

1. Given a set of blue prints of a sewer system, the student should be able to point out the location of five manholes.
2. Given 4 pipes made of different materials, the student should be able to identify at least 3 of the materials.
3. Given a simulated case of high infiltration of storm sewer water into the sanitary sewer system, the student should be able to identify possible causes to the satisfaction of the instructor.
4. Given two pipes to join, the student should be able to properly join the pipes so that they will not leak.

Instructional Resources:

1. Sewer pipes made from 6 different materials
2. Jointing materials
3. Access to a sewer system
4. Several blue prints of sewer systems

Student Performance Objective 2:

While working in a wastewater treatment system, the student will inspect the conditions of sewer systems and correct problems related to laterals and mains so well that the system operates efficiently.

Instructional Areas:

1. Determining emergency maintenance which is usually performed in sewer systems

    a. Identifying stoppages

        (1) Foreign objects
        (2) Materials such as grease, settled solids, sand and gravel
        (3) Bad joints or a broken pipe

    b. Correcting stoppages

        (1) Using flexible steel rod
        (2) Using specially equipped trucks and equipment
        (3) Wearing protective clothing

    c. Identifying structural failures

        (1) Broken pipes
        (2) Cave-ins
        (3) Washouts

    d. Correcting structural failures

        (1) Excavating and replacing pipes
        (2) Rerouting sewage load temporarily

    e. Identifying mechanical failures

        (1) Pumps
        (2) Motors
        (3) Valves

    f. Eliminating overloading of sewer lines

        (1) Releasing excess flows of sewage
        (2) Cleaning to check for partial blockage
        (3) Recommending adequate sewer line capacity

2. Carrying out a routine and preventive maintenance program
   a. Selecting and using sewer cleaning equipment
      (1) Using Rodding machines
      (2) Using Bucket machine
      (3) Using Hydraulic equipment
      (4) Using a sewer ball
   b. Identifying miscellaneous maintenance
      (1) Using television and photography to identify maintenance requirements
      (2) Repairing of manholes
      (3) Broken or defective steps
3. Keeping and analyzing maintenance records
   a. Organizing files
   b. Filing maintenance reports
   c. Interpreting and analyzing reports
   d. Locating reports which have been filed

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and students may visit a sewer system and have several students identify several areas where routine maintenance is necessary for efficient operation of the system.

2. During a heavy rainstorm, the instructor and students may visit a storm sewer system and measure the ability of the system to carry away the water by watching a rain to observe if the water backs up or is carried away.

3. The instructor and students may visit a wastewater treatment workshop area where the instructor may ask several student to explain the use of sewer cleaning equipment.

4. Given a maintenance record of a sewer system, the instructor may ask several students to identify probable areas of reoccuring problems.

Examples of Evaluation Techniques:

1. Given a storm sewer system, the student should be able to point out at least 3 areas where the system would require routine maintenance.

2. Given a flexible steel rod, the student should be able to demonstrate its' use to the satisfaction of the instructor by cleaning out a sewer lateral.

3. Given a simulated emergency situation where a sewer system was stopped up and is releasing hundreds of gallons of wastewater into the street, the student should be able to describe immediate emergency measures which should be performed to correct the situation.

Instructional Resources:

1. Access to sewer system
2. Access to sewer cleaning equipment
3. Protective clothing
4. Maps and diagrams of a sewer system
5. Examples of maintenance records
6. Examples of broken and defective pipes

Student Performance Objective 3:

Given access to various sizes and types of pumps and necessary maintenace equipment, the student will verbally explain the operation of, maintain and operate pumps according to the operator's manual.

Instructional Areas:

1. Identifying Sewage Pumps

    a. Centrifugal pumps consisting of:

        (1) Impeller
        (2) The casing

    b. Displacement pumps

2. Installing centrifugal pumps

    a. Observing 5 basic rules

        (1) Weight of external piping, valves and fitting should not be supported by pump casing

   (2) The suction pipe should slope upward toward the pump and reducers, if any, should be eccentric with the flat side up

   (3) The coupling that connects the pump shaft to the prime mover shaft should be so adjusted as to bring these two shafts into proper alignment

   (4) The pumps should rotate in the proper direction

   (5) The pump and motor foundation as well as the pipe hangers, pedestals, thrust-blocks, etc., should be of adequate strength and rigidity to avoid displacement during pump operation

3. Maintaining sewer pumps

   a. Performing preventive maintenance

      (1) Keeping permanent maintenance records
      (2) Removing impeller and checking for wear
      (3) Inspecting rings
      (4) Inspecting packing rings
      (5) Inspecting shaft sleeve
      (6) Removing and checking bearings
      (7) Examining daily for vibrations and noises
      (8) Lubricating bearings

   b. Performing repairs

      (1) Replacing impeller
      (2) Replacing wearing rings
      (3) Replacing packing rings
      (4) Replacing shaft sleeves
      (5) Replacing bearings
      (6) Removing articles from pump
      (7) Replacing defective check valves

4. Operating pumps

   a. Operating automatically controlled pumps
   b. Operating pumps without automatic controls

      (1) Turning valves to start pump
      (2) Turning valves to regulate flow

Examples of Supporting References:

1. Manual of Wastewater Operation. Texas Water Utilities Association. Texas State Department of Health. Austin, Texas. 1971. Chapter 7.
2. Planning for an Individual Water System. American Association for Vocational Instructional Materials. Engineering Center, Athens, Georgia. 1973. P. 84 ff.

Examples of Student Learning Activities:

1. The instructor and student may visit a wastewater treatment system and the instructor may ask several students to identify and explain two different types of pumps.
2. Given a centrifugal pump model, the instructor may ask several students to explain its operation by pointing to places in the pump where various functions take place.
3. Given a pump with worn packing rings, the student should change the packing rings.

Examples of Evaluation Techniques:

1. Given a pump, the student should be able to remove and check the bearings for wear to the satisfaction of the instructor.
2. Given an automatically operated pump, the student should be able to examine the pump for excessive vibrations and noises.
3. Given a pump that must be manually started by pushing a switch and turning valves, the student should be able to start the pump to the satisfaction of the instructor.
4. Given a motor to be installed, the student should be able to couple the pump shaft with the prime mover shaft with proper alignment.

Instructional Resources:

1. Models of centrifugal and displacement pumps
2. New and used bearings
3. New and worn impeller
4. New and worn wearing rings

5. A pump to install and access to an appropriate place of installation
6. Appropriate equipment

Student Performance Objective 4:

Given various sizes and types of motors, the student will verbally explain the operation of, maintain and operate the pumps according to the operator's manual.

Instructional Areas:

1. Identifying basic types of motors used in a wastewater treatment system

    a. Induction type
    b. Synchronous type

2. Identifying the components of a motor and their operating functions

    a. Stator
    b. Rotor
    c. Frame
    d. Bearings
    e. Shaft
    f. Overload devices

3. Understanding basic operating principles of motors

4. Identifying types of motor enclosures

    a. Drip-proof
    b. Splash-proof
    c. Totally enclosed
    d. Totally enclosed fan cooled

5. Selecting electrical motors

    a. Determining size (horsepower) of motor needed and the feasibility for using a single phase of 3-phase motor
    b. Determining motor speed (RPM) needed
    c. Determining motor duty needed and type

        (1) Continuous duty
        (2) Intermittent duty

d. Considering the effects of starting load, starting current and other factors relative to determining motor type needed
e. Considering method and frequency of lubrication and mounting position in selecting sleeve or ball type bearings.
f. Considering the types of enclosures on electric motors
g. Considering the types of mounting bases for electric motors

(1) Rigid
(2) Cushioned

6. Servicing electrical motors

a. Lubricating motors
b. Checking for loose contacts
c. Securing hold-down bolts
d. Checking voltage
e. Examining bearings and couplings
f. Noting all unusual conditions

(1) Noises
(2) Smell or feel hot
(3) Brush chatter
(4) Vibration
(5) Smoke, charred insulation
(6) Sluggish operation

7. Performing motor repair

a. Changing bearing
b. Rewinding motor
c. Changing brushes
d. Changing belts and pulleys
e. Replacing overload device

Examples of Supporting References:

In addition to the supporting references discussed under Student Performance Objective 1, the following may be found useful.

1. How Electric Motors Start and Run. American Association for Vocational Instructional Materials, Engineering Center, Athens, Georgia. 1973.

2. Electric Motors, Selection Protection, Drives. American Association for Vocational Instructional Materials. Engineering Center, Athens, Georgia. 1972.

Examples of Student Learning Activities:

1. Given a three phase squirrel cage induction motor, the instructor may ask several students to disassemble the motor and point out the various components.
2. Given an electrical motor and service book, the instructor may ask several students to lubricate the motor according to manufacturer's specifications.
3. Given a volt meter and motor, the instructor may ask several students to test the voltage on a motor.
4. Given a motor with worn bearings, the instructor may ask several students to change the bearings.
5. Given two magnets, the instructor may ask several students to use the magnets in describing how a motor operates.
6. The instructor may ask each student to visit a wastewater treatment lift station and obtain size (HP) and speed (RPM) from various types of motors in the operation.

Examples of Evaluation Techniques:

1. Given a three phase motor, the student should be able to disassemble and identify at least four major components
2. Given a motor and service manual, the student should be able to lubricate the motor according to manufacturer's specifications
3. Given a set of motor bearings, the student should be able to tell whether the bearings are excessively worn or not.
4. Given a rigid mounting base, the student should be able to mount a motor to the satisfaction of the instructor.

5. Given a pump and appropriate motor, the student should be able to select the correct belt and attach it so that the equipment operates satisfactorily.

6. Given a tachometer, the student should be able to determine the speed at which a given motor is running.

Instructional Resources:

1. Single phase and three phase motors
2. Access to a lift station
3. Voltage meter
4. Tachometer
5. Set of new and worn motor bearings
6. Set of magnets
7. Set of belts and pulleys
8. Rigid motor mount
9. Motor and appropriate service manual

Student Performance Objective 5:

Given access to the electrical power system in a wastewater lift station, the student will verbally explain and maintain the system according to operator's manual.

Instructional Areas:

1. Identifying components of the electrical distribution system and their operating functions
   - a. The transfer bank
   - b. The meter loop
   - c. The main disconnect switch which may or may not have fuses or circuit breakers
   - d. An individual motor circuit disconnect switch which may or may not have fuses or circuit breakers
   - e. A magnetic motor starter
   - f. A hand-off automatic switch
   - g. A control device
   - h. The circuit from starter to the motor

2. Maintaining the electric distribution system
   - a. Changing fuses
   - b. Operating circuit breakers
   - c. Checking loose connections
   - d. Testing circuits
   - e. Observing safety precautions

    (1) Insulated floor mats
    (2) Insulated gloves
    (3) Fuse pullers

Examples of Supporting References:

1. Manual of Wastewater Operations. Texas Water Utilities Association. Texas State Department of Health. Austin, Texas. 1971. pp. 127 ff.

Examples of Student Learning Activities:

1. The instructor and students may visit a wastewater treatment lift station and have several students point out and explain the various components of the electrical distribution system.

2. Given a fuse box, the instructor may have several students test an electrical circuit for the amount of voltage being carried.

Examples of Evaluation Techniques:

1. Given a fuse box, fuse puller and fuses, the student should be able to change a fuse to the satisfaction of the instructor.

2. Given an electric distribution system, the student should be able to identify at least 5 components of the system.

3. The instructor may have each student check the fuse box in their own homes and record the correct number and sizes of fuses.

Instructional Resources:

1. Fuses
2. Circuit breakers
3. Voltage meters
4. Access to an electrical distribution system at a lift station

Student Performance Objective 6:

Given access to the metering devices used at wastewater treatment systems, the student will read the meters and verbally interpret the readings according to the terminology used in interpreting meters used in wastewater treatment systems.

Instructional Areas:

1. Identifying the types of metering devices used in wastewater treatment systems and their functions.
    - a. Pressure measuring devices
    - b. Temperature measuring devices
    - c. Flow measuring devices
    - d. Level measuring devices
2. Reading and recording metering device readings
3. Interpreting metering device readings

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and student may visit a wastewater treatment system and have the student record the pressure, temperature and flow metering devices observed.
2. Given a Parshall flume chart, the instructor may ask the student to calculate the amount of flow traveling through the Parshall flume when the level is at a .5 foot head and the throat width is 1 foot.
3. Given access to a pond, the instructor may ask the students to measure the depth of the water with the use of a gauge stick.

Examples of Evaluation Techniques:

1. Given information relative to head and throat width, the student should be able to calculate the amount of flow through a Parshall flume within 90% accuracy.
2. Given a thermometer, the student should be able to measure the temperature of water within 3 degrees accuracy.
3. Given access to a pressure gauge, the student should be able to read the gauge within 90% accuracy.

Instructional Resources:

1. Access to flow measuring devices such as Parshall flumes, weirs and venturi meters
2. Thermometer
3. Gauge stick
4. Charts used to calculate flow in various flow measuring devices

Student Performance Objective 7:

When visiting a lift station, the student will identify the parts of the station and verbally explain their operations according to the operating manual.

Instructional Areas:

1. Identifying the types of lift stations and their operations
    a. Wet-well
    b. Dry-well
2. Identifying types of valves and their functions
    a. Gate valves
    b. Plug valves
    c. Check valves
3. Identifying types of fittings and their functions
    a. Flange fittings
    b. Flexible connections
4. Identifying types of screens and their functions
    a. Hand-raked screens
    b. Mechanically cleaned bar screens
    c. Communinutors
5. Identifying types of panels which are used to monitor operations at the lift station

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and students may visit a wastewater lift station where several students may identify and explain the functions of screening devices used in that station.
2. Given a check valve, the instructor may ask several students to explain the operating principles.
3. Given a monitoring control panel at a lift station, the instructor may ask several students to identify the meters and lights and describe the operations that are being monitored.

Examples of Evaluation Techniques:

1. Given diagrams of wet-well and dry-well lift stations, the student should be able to explain both types to the satisfaction of the instructor.
2. Given a flange fitting, the student should be able to disconnect the fitting from pipes and explain the functions of the fitting to the satisfaction of the instructor.
3. Given a console of monitoring equipment, the student should be able to describe the operations occuring from the lights flashing on the panel to the satisfaction of the instructor.

Instructional Resources:

1. Diagrams of wet and dry-well type lift stations
2. Flange fittings
3. Check valves
4. Access to screening devices
5. Access to panels which are used to monitor operations at the lift station

MODULE OF INSTRUCTION

CODE--01.99

OPERATING, SERVICING AND REPAIRING AERATORS

Module Concept: Air is introduced into wastewater to increse metabolic processes of living organisms and to scrub out volatile metabolic waste products. In wastewater treatment systems, the aeration process is very important because the treatment process is designed to reduce Biochemical Oxygen Demand (BOD).

The purpose of this module is to depict the instructional areas which should be covered by the instructor so that the student will be capable of operating the aeration equipment and understands the basic principles of operation.

Prerequisites: The module on Using Safety Practices In Operating Wastewater Treatment Systems should perhaps be covered before undertaking this module. Relevant courses in chemistry and biology could be helpful.

Module Goal: When this module is completed, the student will be able to understand the functions of, operate, service and repair aeration equipment.

Student Performance Objective 1: Given access to an aerator and repair manual, the student will identify the component parts and describe verbally or in writing the functions of each component according to information in given manual.

Instructional Areas:

1. Identifying the components of aeration equipment and their functions:

   a. Power section
   b. Support beam assembly
   c. Pressure plate assembly
   d. Floats
   e. Flared intake cone
   f. Fasteners

2. Determining the reaction processes which occur when treating waste during the aeration stage
    a. Substances that produce tastes and odors such as organic compounds
    b. Substances that increase the corrosive action of water such as carbon dioxide and hydrogen sulfide
    c. Substances that interfer with water treatment chemicals such as carbon dioxide and hydrogen sulfide
    d. Miscellaneous gases such as methane
    e. Oxygen which assists in the oxidation of materials
    f. Carbon dioxide can be added instead of oxygen to neutralize causticity

Examples of Supporting References:

1. Aeration in Wastewater Treatment. Water Control Federation. WPCF Manual 5. Washington, D.C. 1971.
2. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970.
3. Muskegon County, Michigan Wastewater Management System No. 1. Bauer Engineering, Inc. A 15 page document giving a brief description of the Muskegon County Wastewater Treatment System. 1973.
4. Manual of Wastewater Operation. Texas Water Utilities Association. Texas State Department of Health, Austin, Texas. 1971.
5. Career Preparation in Environmental Protection. Ohio Career Education and Curriculum Management Laboratory in Agricultural Education. The Ohio State University. Columbus, Ohio. 1974.
6. Installation, Operation, and Maintenance Manual for Aqua-Jet Aerators. Aqua-Aerobic Systems. 6303 N. Alpine Rd. Rockford, Ill. 61111.

Examples of Student Learning Activities:

1. Given access to an aerator, the instructor may ask several students to identify the float and list the functions of the float.
2. Given a sample of wastewater, the instructor may ask a student to test the sample for oxygen content by using appropriate testing equipment and reagents.

Examples of Evaluation Techniques:

1. The instructor may prepare a diagram of an aerator and the students should be able to list at least four major components of the equipment.
2. With access to an aerator, the student must be able to identify at least four parts and explain their functions to the satisfaction of the instructor.

Instructional Resources:

1. Access to an aerator
2. Water samples and sampling equipment
3. Testing equipment and appropriate reagents for determining oxygen and carbon dioxide

Student Performance Objective 2:

Given access to an aerator in a wastewater treatment system, the student will operate the equipment according to operator's manual.

Instructional Areas:

1. Starting aerator
    a. Checking cells for debris and other damaging objects
    b. Checking cells to determine quantity and quality of effluent in order to determine aeration requirements
    c. Locating appropriate controls and turning on aerator
    d. Checking aerators for proper operation
2. Turning off aerators
    a. Locating controls and turning off aerators

  - b. Checking quality of effluent

3. Reversing and jogging the aerator on and off when feasible
   - a. Checking for poor discharge
   - b. Checking for uneven discharge

Examples of Supporting References:

Supporting References were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and students may visit an operational aerator and the instructor may ask several students to describe the flow of the aerator and explain whether that flow is appropriate to the conditions.
2. Given an aerator, the instructor may ask several students to turn off and restart the aerator and explain under what conditions the aerator should be turned off.

Examples of Evaluation Techniques:

1. Given an aerator, the student should be able to start the equipment and explain to the satisfaction of the instructor if the aerator is functioning properly.
2. Given an aerator, the student should be able to turn it off and explain under what conditions it should be turned off to the satisfaction of the instructor.

Instructional Resources:

1. Access to an operational aerator
2. Operating manual for aerator
3. Appropriate protective clothing

Student Performance Objective 3:

Given access to an aerator and the appropriate service equipment, the student will service the equipment according to service manual.

Instructional Areas:

1. Lubricating aeration equipment
    a. Identifying parts to be lubricated from service manual
    b. Selecting the lubricants and lubricating equipment
    c. Lubricating the equipment
    d. Storing lubricants and lubricating equipment
2. Checking mooring lines
    a. Determining appropriate tightness and tightening when necessary
    b. Determining if lines are securely fastened on each end
3. Securing an amperage check on the motors
    a. Locating ammeter
    b. Attaching ammeter to motor
    c. Reading the amperage from the ammeter

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a service manual to an aerator, the instructor may ask the students to read and explain the procedure for lubricating the motor.
2. Given a mooring line in an operational cell, the instructor may ask several students to check and explain if the line is appropriately tightened.

Examples of Evaluation Techniques:

1. Given a motor and manufacturer's manual, the student should be able to lubricate the motor according to the manufacturer's specifications.
2. Given an ammeter, the student should be able to check the amperage of a given motor within 90 percent accuracy.

Instructional Resources:

1. Access to an operational aerator
2. Manufacturer's manual for the aerator
3. Ammeter
4. Lubricating equipment and lubricants

Student Performance Objective 4:

Given an aerator, appropriate manual, tools and equipment, the student will disassemble the equipment, repair and reassemble the equipment according to repair manual.

Instructional Areas:

1. Removing the aerator from the basin
    a. Selecting and wearing life preservers
    b. Shutting down the aerator
    c. Selecting the appropriate type of boat
    d. Selecting the appropriate type of tools and equipment
    e. Loosening the appropriate bolts
    f. Floating the unit to shore and securing the equipment
    g. Selecting the appropriate hoist
    h. Lifting the unit out of the water
2. Disassembling the aerator
    a. Selecting the appropriate tools for disassembling
    b. Removing the safety wire from the motor
    c. Removing bolts and lifting the power section out and away from the boat
    d. Removing the propeller
    e. Removing the motor from the diffuser
    f. Organizing parts on work bench
3. Servicing the motor

    (The instructor may desire to refer to the module on *Collecting and Transporting Wastewater to Designated Site* for materials which should be covered in servicing and repairing motors).
4. Cleaning the intake and diffuser openings
    a. Checking for debris
    b. Cleaning out algae and other growth

5. Repairing the motor
    a. Inspecting and replacing neoprene slinger and fluid deflector
    b. Inspecting and repairing anti-deflector insert in the diffuser

6. Reassembling the aerator
    a. Lowering the motor into support casting and bolting down
    b. Reassembling the propeller onto the motor
    c. Lowering power section onto the float and bolting it down
    d. Affixing the safety wires

7. Replacing the unit in the basin
    a. Wearing life preserver and using appropriate boat, float the unit into place
    b. Bolting the unit in place by using the appropriate tools
    c. Attaching and tightening mooring cables
    d. Testing the unit for satisfactory operation

Examples of Supporting References:

1. Installation, Operation and Maintenance Manual for Aqua-Jet Aerators. Aqua-Aerobic Systems. 6306 N. Alpine Road, Rockford, ILL. 61111.

Examples of Student Learning Activities:

1. At the operational aeration cell lagoon, the instructor may have several students select life preservers and a boat and row out to an aerator which has been turned off for visual inspection. The instructor should accompany the students.

2. Visiting the workshop area, the instructor may have several students select the appropriate equipment to put in the boat to remove the aerator from the basin.

3. Given an aerator in the workshop area, the instructor may have several students remove and inspect the motor

Examples of Evaluation Techniques:

1. Given an aerator in a basin, three students should be able to remove the aerator unit from the basin to the satisfaction of the instructor.

2. Given an aerator diffuser, the student should be able to inspect and clean the diffuser holes as required to the satisfaction of the instructor.

3. Given a fluid deflector, the student should be able to inspect the equipment for excessive wear and determine if it requires replacement. The instructor may desire to repeat this evaluation process and evaluate student based on his/her recommendation.

Instructional Resources:

1. Access to an operational aerator
2. Access to a complete aerator unit in a workshop
3. Rowboat
4. Life preservers
5. Appropriate protective clothing
6. Appropriate tools for disassembling and reassembling aerators
7. Appropriate tools for repair of aerators
8. Defective propeller, fluid deflector and anti-deflector insert
9. Appropriate hoist for lifting aerator out of basin

MODULE OF INSTRUCTION

CODE--01.99

OPERATING, SERVICING AND REPAIRING MIXERS

Module Concept: In the aeration tank, oxygen in the form of air is introduced to increase the metabolic process of living organisms. Mixing is often used in large aeration tanks to prevent the solids from settling and to keep the organisms in close contact with the dissolved and suspended organic matter for increased efficiency of the metabolic process.

The purpose of this module is to depict information that will assist the wastewater treatment personnel in understanding functions and operation of mixing equipment in aeration lagoons.

Prerequisites: A module of study on Safety Practices in Wastewater Treatment Systems and a module on Operating, Servicing and Repairing Aerators is recommended before this module of study is undertaken.

Module Goal: When this module is completed, the student will be able to understand the functions of, operate, service and repair mixing equipment.

Student Performance Objective 1: Given access to a mixer and repair manual, the student will identify the component parts and describe verbally or in writing the functions of each component according to information in given manual

Instructional Areas:

1. Identifying the components of mixers and their functions
   - a. Agitator assembly
   - b. Pedestal
   - c. Motor
   - d. Flexible couplings
   - e. Gear drives
   - f. Seals
   - g. Shafts and impellers
   - h. Steady bearings
2. Identifying the reasons for mixing

a. Preventing the settling of solids in the aeration lagoon
b. Keeping organisms in close contact with dissolved and suspended organic matter
c. Working in conjunction with the aerators to churn the surface of the water and introduce atmospheric oxygen

Examples of Supporting References:

1. Chemineer Instruction Manual-Installation, Operation, Maintenance. Chemineer Agitators. P.O. Box 1123, Dayton, Ohio.

2. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970. pp. 3-22.

Examples of Student Learning Activities:

1. The instructor may have the students collect a sample of wastewater and let it stand overnight, observing the next day the amount of solids that settled out in that time and explain reasons for the occurance.

2. The instructor and students may visit an operational aeration lagoon in which a mixer is operating and observing the mixer, the instructor may have several students explain the operation of the mixer and reasons for mixing the effluent.

3. The instructor and students may study a model of a mixer and have several students identify the various components of the mixer.

Examples of Evaluation Techniques:

1. Given a model of a mixer commonly used in an aeration lagoon, the student should be able to identify at least 4 major components of the mixer.

2. Given a hand mixer and a sample of water containing at least 10% organic soil, the student should be able to demonstrate to the satisfaction of the instructor how mixing keeps organic matter in suspension and explain the reasons for doing so.

Instructional Resources:

1. Model of a mixer
2. Access to an aeration lagoon containing an operational mixer
3. Samples of wastewater and sampling equipment
4. Hand mixer
5. Sample of water containing organic soil

Student Performance Objective 2:

Given access to a mixer in a wastewater treatment system the student will operate the equipment according to operator's manual.

Instructional Areas:

1. Starting mixers
    a. Checking lagoons for debris and other damaging objects
    b. Checking lagoons for specific gravity or viscosity against that for which the unit was designed
    c. Checking impeller to make sure it is not buried in solids
    d. Locating appropriate controls and turning on mixer
    e. Checking agitator for proper rotation of low speed shaft
    f. Checking stuffing boxes or mechanical seals and operating only at temperatures for which the unit was designed
2. Turning off mixers
    a. Locating controls and turning off mixers
    b. Checking quality of effluent

Examples of Supporting References:

Examples of supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and students may visit a mixer which is in operation and the instructor may ask several students to observe the rotation of the gear drive output shaft and explain how to determine whether the rotation is correct and why correct rotation is important.

2. Given access to a mixer, the instructor may ask one student to check the lagoon for debris and turn the mixer on when appropriate.

3. Given two samples of wastewater, one below and one above specific gravity designed for the mixer, the instructor may ask several students to test the samples for specific gravity with appropriate equipment and explain whether or not the mixer is designed for mixing the samples.

Examples of Evaluation Techniques:

1. Given a sample of wastewater, the student should be able to test the sample with appropriate equipment for specific gravity within 90% accuracy.

2. Given access to a mixer, the student should be able to explain what precautions are required before turning the equipment on and demonstrate techniques for turning on the mixer to the satisfaction of the instructor.

Instructional Resources:

1. Access to an operational mixer
2. Sampling equipment and samples of wastewater
3. Operating and servicing manuals
4. Testing equipment for checking specific gravity

Student Performance Objective 3:

Given access to a mixer and the appropriate service manual, the student will service the equipment according to service manual.

Instructional Areas:

1. Lubricating mixing equipment
    a. Identifying parts to be lubricated from service manual
    b. Selecting the appropriate lubrication and lubricating equipment
    c. Lubricating the major component parts
        (1) Motors
        (2) Gear drives
        (3) Seals

2. Securing an amperage check on the motors
    a. Securing an ammeter

   b. Attaching an ammeter to motor
   c. Reading the amperage from ammeter and comparing with motor nameplate amperage

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a service manual to a mixer, the instructor may ask students to read and demonstrate the procedures for lubricating the motor.

2. Given a motor nameplate, the instructor may ask several students to locate and determine the designed amperage of that motor.

Examples of Evaluation Techniques:

1. Given a service manual, the student should be able to select the appropriate lubrication according to manufacturer's specifications.

2. Given appropriate lubrication, lubricating equipment, and service manual to a motor, the student should be able to lubricate a motor according to manufacturer's specifications.

3. Given an ammeter, the student should be able to check the amperage of a mixer motor with 90% accuracy.

Instructional Resources:

1. Access to an operational mixer
2. Access to a mixer in a workshop area
3. Lubricants and lubricating equipment
4. Service manual for mixer
5. Ammeter

Student Performance Objective 4:

Given access to a mixer, the student will disassemble the equipment, repair and reassemble the equipment according to repair manual.

Instructional Areas:

1. Removing the mixer from the basin

   a. Selecting and wearing life preservers

   b. Shutting down the mixer
   c. Selecting the appropriate type of boat for maneuvering in effluent in order to reach mixer
   d. Selecting the appropriate type of tools and equipment for removing mixer from basin
   e. Loosening the appropriate bolts
   f. Taking the unit to shore
   g. Selecting the appropriate hoist
   h. Lifting the mixer out of the effluent

2. Disassembling the mixer

   a. Removing the drive assembly
   b. Removing agitator assembly shaft
   c. Disassembling the gear drive

3. Servicing the motor

   (The instructor may desire to refer to the module on Collecting and Transporting Wastewater to Designated Site for materials which should be covered in servicing and repairing motors).

4. Determining operating problems

   a. Identifying noisy operations

      (1) Checking for worn or damaged parts
      (2) Checking for overloading
      (3) Checking for worn or improperly installed or maintained couplings
      (4) Checking for structure amplification

   b. Identifying abnormal heating

      (1) Checking for improper oil
      (2) Checking for unusual ambient conditions
      (3) Checking for improper oil level

   c. Identifying leaking problems

      (1) Checking for worn oil seals
      (2) Checking for too high oil level
      (3) Checking for oil in dry well
      (4) Checking for plugged breather

5. Replacing mixer parts with appropriate tools

   a. Worn parts
   b. Broken parts

6. Reassembling major parts to the mixer
    a. Assembling the gear drive
    b. Replacing the agitator assembly shaft
    c. Replacing the drive assembly
7. Replacing the unit in the basin
    a. Wearing life preserver and using appropriate rowboat to take unit to the site of mounting
    b. Bolting the unit in place using appropriate tools
    c. Testing the unit for satisfactory [illegible]ation

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. In the workshop area, the instructor may ask several students to select an appropriate hoist for lifting the mixer out of the basin.

2. Given access to a gear drive, the instructor may ask several students to disassemble the gear drive.

3. Given a plugged breather, the instructor may ask two students to clean the breather with appropriate cleaning material.

Examples of Evaluation Techniques:

1. Given a mixer that is noisy in operation, the student should be able to list at least two possible causes for such noises and explain how to eliminate the cause.

2. Given a new set of reducer bearings, the student should be able to replace them according to manufacturer's specifications.

3. Given a worn bearing, the student should be able to list at least 3 possible reasons for the worn condition.

Instructional Resources:

1. Access to an operational mixer
2. A set of new and used bearings, lip seals and gaskets for the gear drive
3. Life preservers

4. Rowboat
5. Appropriate protective clothing
6. Appropriate tools for disassembling and reassembling mixers
7. Appropriate hoist for lifting mixer out of basin
8. Appropriate tools for repair of mixers
9. Access to a mixer unit in a workshop area

MODULE OF INSTRUCTION

CODE--01.99

DISINFECTING AND CHLORINATING EFFLUENT

Module Concept: Disease producing (pathogenic) organisms are potentially present in all wastewater and those organisms must be removed or killed before treated wastewater can be discharged into lakes, streams or rivers. By various treatment processes, pathogenic organisms are reduced. Chlorination is used to kill the remaining pathogenic organisms. Chlorine is an acceptable disinfectant and is available at a reasonable cost, consequently other disinfecting agents are usually not used.

The purpose of this module is to provide the instructor with information that will assist the student in understanding chlorination principles, operation and servicing in such a way that the student may be able to safely and efficiently operate chlorination equipment.

Prerequisites: Modules on Using Safety Practices in Wastewater Treatment Systems should be covered before this module is undertaken. Courses in biology and chemistry would be useful.

Module Goal: When this module of instruction is completed, the student will be able to safely handle, operate and service chlorination equipment.

Student Performance Objective 1: Given the task of explaining the principles of chlorination in treating waste, the student will explain verbally or in writing the principles of chlorination in treating waste according to appropriate reference materials.

Instructional Areas:

1. Determining purposes of disinfecting with chlorine
   - a. Destroying pathogenic organisms
   - b. Destroying non-pathogenic organisms
   - c. Reducing odors
2. Determining the reaction of chlorine in wastewater
   - a. Reacting with water
   - b. Reacting with sulfides
   - c. Reacting with ammonia
   - d. Reacting with nitrites
   - e. Forming organic chloramines

3. Determining reasons for variations in Most Probable Number (MPN)
    a. Taking samples from a point where all of the wastewater flows
    b. Taking small samples from a large body of water
    c. Considering many varying factors
    d. Testing under various conditions

4. Determining chlorine demand
    a. Considering volume to be chlorinated
    b. Considering temperature
    c. Considering strength of effluent
    d. Considering chlorine residual

Examples of Supporting References:

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970.

2. Manual of Instruction for Sewage Treatment Plant Operators. Health Education Service. P.O. Box 7283 Albany, New York. 12224.

3. Manual of Wastewater Operations. Texas Water Utilities Association. Texas State Department of Health, Austin, Texas. 1971.

4. Operation of Wastewater Treatment Plants. Water Pollution Control Federation. WPCF Manual of Practice No. 11. Washington, D.C. 1970.

5. Wastewater Treatment Plant Operator Training Course One. Water Pollution Control Federation. WPCF Publication No. 14. Washington, D.C. 1967.

6. Wastewater Treatment Operator Training Course Two. Water Pollution Control Federation. WPCF Publication No. 14. Washington, D.C. 1967.

Examples of Student Learning Activities:

1. Using a microscope, the instructor may have several students inspect two samples of wastewater, one sample should be previously treated with chlorine and the second sample should not be treat with chlorine. Students should inspect the two samples for pathogenic organisms.

2. Given a volume of wastewater with chlorine residual the instructor may have several students calculate the chlorine demand.
3. Given a chlorine control monogram, the instructor may ask a student to use the monogram in explaining the variables in treating wastewater.

Examples of Evaluation Techniques:

1. Given a volume of wastewater with chlorine residual, the student should be able to calculate the chlorine demand correctly.
2. Given a microscope and samples of disinfected wastewater, the student should be able to identify at least one living organism and indicate whether or not it is pathogenic.
3. Given a chlorine control monogram, students should be able to demonstrate the proper use of the monogram to the satisfaction of the instructor.

Instructional Resources:

1. Samples of untreated and disinfected wastewater
2. A chlorine control monogram
3. Microscope
4. Glass slides of wastewater containing pathogenic organisms

Student Performance Objective 2:

While visiting a wastewater treatment chlorination system, students will identify the basic equipment in the system by their common names and explain verbally or in writing their operating principles according to appropriate reference materials.

Instructional Areas:

1. Identifying types of chlorinators and their basic principles of operation
    a. Dry feed gas chlorinator
    b. Solution feed gas chlorinator
    c. Electrolytic cell gas chlorinator
    d. Hypochlorinators
2. Identifying types of evaporators and their basic principles
    a. Immersion heater supply
    b. Hot water supply

3. Identifying the types of piping, valves and manifolds found in chlorination systems and their basic principles of operation

4. Identifying the types of chlorinator control equipment and their functions

   a. Manual
   b. Semi-automatic
   c. Fully automatic

5. Identifying other types of equipment found in chlorination systems and their functions

   a. Measuring dosage equipment

      (1) Scale
      (2) Loss-in-weight recorders

   b. Water supply and pumps
   c. Hoisting equipment
   d. Storing cylinders

      (1) Cylinders which are 100 lb., 150 lb. and 1 ton
      (2) Tank cars of 16, 30 and 50 tons

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and student may visit a wastewater treatment chlorination system and the instructor may ask several students to identify and explain the operation of the chlorinator.

2. The instructor may ask three students to demonstrate the proper use of a scale in weighing a chlorine cylinder.

3. The instructor may ask three students to demonstrate the use of a hoist in moving a chlorine cylinder.

4. The instructor may ask several students to demonstrate the proper procedure for opening and closing a valve in a chlorination system.

Examples of Evaluation Techniques:

1. The student should be able to explain the purpose of a water supply in a chlorination system to the satisfaction of the instructor.

2. Given a scale, the student should be able to weigh a chlorine cylinder to within 4 pounds of the correct weight.

3. Given manually operated chlorinator control equipment, the student should be able to operate the controls to the satisfaction of the instructor.

4. Given a chlorine cylinder, the student should be able to replace the protective cap to the satisfaction of the instructor.

Instructional Resources:

1. Access to a wastewater treatment chlorination system
2. Diagrams of several different chlorination systems
3. Access to appropriate hoist and chlorine cylinders
4. Scales for weighing

Student Performance Objective 3:

While working in a wastewater treatment chlorination system, the student will identify chlorine safety equipment, and demonstrate safety procedures in working with chlorination equipment and materials according to operating manual.

Instructional Areas:

1. Identifying types of gas masks and their uses

    a. Canister masks
    b. Hose masks
    c. Air-demand masks

2. Following safety precautions in handling cylinders

    a. Keeping cylinders away from excessive heat
    b. Handling cylinders so there will be no danger of their falling
    c. Following manufacturer's instructions in care and operation of valves
    d. Making all connections properly and checking for leaks
    e. Storing cylinders with protective hood in place

3. Handling leaks
    a. Locating leaks with ammonia, not smell
    b. Using an emergency leak kit in repairing leaks
    c. Determining reasons for repairing leaks immediately
    d. Running chlorinator at peak capacity to slow leak

4. Providing safe working conditions for employees
    a. Heating buildings at desired temperatures
    b. Ventilating rooms
    c. Using safety practices in handling and storing materials and equipment
    d. Organizing and cleaning work areas
    e. Providing proper lighting

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a simulated chlorine leak, the instructor may ask several students to use a self-contained breathing apparatus in inspecting equipment for leaks.

2. Given a chlorine cylinder to change, the instructor may ask several students to use the appropriate tools and fittings to change the cylinder.

3. The instructor may give several students a bottle of ammonia and ask them to check a chlorine cylinder for leaks.

4. The instructor may give several students a manufacturer's instruction manual and ask the students to read and explain the operation of valves.

5. The instructor may ask several students to demonstrate the proper techniques in storing chlorine cylinders.

6. Given a simulated chlorine leak and a leak repair kit, the instructor may ask several students to demonstrate the use of the repair kit in stopping the leak.

7. While visiting a chlorine building, the instructor may ask several students to point out factors that contribute to safe working conditions in the buildings.

Examples of Evaluation Techniques:

1. Given gas masks, students should be able to demonstrate the proper techniques in putting masks on to the satisfaction of the instructor.

2. Given appropriate repair kits, students should be able to repair a pin-hole size chlorine leak in a cylinder in such a way that the leak is completely stopped.

3. Given the task of relocating chlorine cylinders, student should be able to demonstrate the appropriate procedures to use in handling chlorine cylinders to the satisfaction of the instructor.

4. Given the task of changing a chlorine cylinder and appropriate tools, students should be able to change a chlorine cylinder in such a way that no leakage occurs.

5. Given a bottle of ammonia, the student should be able to test for chlorine leaks to the satisfaction of the instructor.

6. The student should be able to list at least three hazards of chlorine gas.

Instructional Resources:

1. Access to a chlorination system
2. First aid kit containing appropriate supplies for treatment of chlorine accidents
3. Gas masks
4. Bottle of ammonia
5. Protective clothing
6. Chlorine leak repair kit of appropriate size
7. Chlorine cylinders and appropriate size hoist

Student Performance Objective 4:

Given access to chlorination equipment, the student will service the equipment as recommended by the manufacturer to maintain the equipment in an efficient working condition.

Instructional Areas:

1. Making minor repairs on chlorination equipment

    a. Checking parts which wear quickly
    b. Using appropriate equipment in making minor repairs
    c. Making adjustments on equipment
    d. Recording condition of equipment before and after minor repairs have been made

2. Lubricating chlorination equipment

    a. Selecting grease and oils
    b. Identifying the types of lubricating equipment
    c. Identifying parts requiring grease and oils
    d. Servicing specified systems and/or parts according to manufacturer's specifications
    e. Setting up a lubrication schedule according to the operation

        (1) Using servicing records
        (2) Using service manuals

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may have several students replace new gaskets at a connection between the chlorine tank and the chlorinator.

2. The instructor may have three students paint the exterior casing of a chlorinator.

3. The instructor may have several students clean the water strainer on a chlorinator

4. Given a service manual, the instructor may have several students read the manual and lubricate a chlorinator

Examples of Evaluation Techniques:

1. The student should be able to lubricate the chlorinator with appropriate lubricants and equipment according to manufacturer's specifications.

2. Given appropriate equipment and the task of changing gaskets to prevent chlorine leaks at connections, the student should be able to change the gaskets

so well that the leaks are stopped and is performed to the satisfaction of the instructor.

3. The student should be able to read and interpret the lubrication schedule in the manufacturer's service manual to the satisfaction of the instructor.

Instructional Resources:

1. Access to a chlorinator
2. Gaskets
3. Painting equipment and paint
4. Appropriate lubricants and lubricating equipment
5. Bottle of ammonia
6. Manufacturer's manual for chlorinator, evaporator and motors
7. Appropriate tools for servicing chlorinator equipment

Student Performance Objective 5:

Given the appropriate equipment and reagents, the student will follow directions in measuring chlorine residue with 95% accuracy and according to the procedures in given manual.

Instructional Areas:

1. Using the comparator kit in measuring chlorine residual

   a. Adding correct ortho-tolidine solution to one of the comparator cells
   b. Filling the two comparator cells with the appropriate amount of sample
   c. Allowing the color to develop for the appropriate time
   d. Reading the results

2. Using the 2-ounce French square bottle in measuring chlorine residual

   a. Adding correct ortho-tolidine solution to a 2-ounce French square bottle
   b. Adding the appropriate amount of sample to the bottle containing ortho-tolidine and to a second bottle which is empty
   c. Allowing the color to develop for the appropriate time
   d. Reading the results

Examples of Supporting References:

1. Standard Methods for the Examination of Water, Sewage and Industrial Wastes. Tenth Edition. American Public Health Association. New York, N.Y.
2. Manual of Instruction for Sewage Treatment Plant Operators. Health Education Service, P.O. Box 7283. Albany, New York 12224.

Examples of Student Learning Activities:

1. The instructor may ask each student to perform the chlorine residual test with the appropriate equipment and reagents
2. The instructor may have each student look through the eyepiece in a comparator and match the rotating color disc with the sample.

Examples of Evaluation Techniques:

1. Using a comparator kit, the student should be able to perform the chlorine residual test with 95% accuracy and the procedures are performed to the satisfaction of the instructor.
2. Given several samples to be observed, the student should be able to match the rotating color disc with the samples in a comparator cell with 95% accuracy.

Instructional Resources:

1. Comparator kit
2. Standard colored glass discs
3. Bottle of ortho-tolidine reagent
4. Medicine dropper
5. Wastewater samples

MODULE OF INSTRUCTION

CODE--01.99

STORING EFFLUENT AND MAINTAINING STORAGE LAGOONS

Module Concept:	Wastewater is usually stored in storage lagoons where natural processess occur which stablizes the wastewater. Heavy solids settle to the bottom while the lighter material is broken down by bacteria in suspension. Storage lagoons must be properly maintained in order to prevent undesirable growth. The purpose of this module is to enable wastewater treatment personnel and students to understand the functions of storage lagoons and how to maintain them.
Prerequisites:	Admission in the Environmental Technology Program is sufficient evidence of qualifications for entry into the course. Relevant courses in biology and chemistry would be helpful.
Module Goal:	When this module of instruction is completed, the student will understand the functions of storage lagoons.
Student Performance Objective 1:	After receiving appropriate instruction, the student will explain verbally or in writing the biological processes that occur in storage lagoons according to appropriate reference materials

Instructional Areas:

1. Identifying the types of storage lagoons and their functions
   - a. Determining the characteristics of aerobic lagoons
     - (1) Distribution of dissolved oxygen
     - (2) Depth
     - (3) Ways of securing additional sources of oxygen
   - b. Determining the charactertistics of anaerobic ponds
     - (1) Depth
     - (2) Odor

(3) Advantages of destroying organic waste

c. Determining the characteristics of facultative ponds

(1) Aerobic and anaerobic layers
(2) Depth
(3) Growth
(4) Detention time
(5) Stabilization of influent
(6) Methane fermentation

Examples of Supporting References:

Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970.

Examples of Student Learning Activities:

1. The instructor and student may visit one or more of the different types of lagoons and the instructor may ask several students to identify the characteristics of the lagoon.
2. Given a sample of wastewater in which anaerobic biological processes are occuring, the instructor may ask several students to explain the aerobic or anaerobic processes.

Examples of Evaluation Techniques:

1. Given access to a facultative lagoon, the student should be able to explain at least four characteristics of a facultative lagoon.
2. Given a rotten-egg odor in a wastewater treatment system, the student should be able to determine whether the biological process is aerobic or anaerobic.

Instructional Resources:

1. Access to one or more types of storage lagoons
2. Samples of wastewater with aerobic and anaerobic biological processes occuring in them

Student Performance Objective 2:

Given blue prints of a lagoon, the student will verbally explain the lagoon design as specified in the blue print by using terminology in appropriate reference.

Instructional Areas:

1. Determining elements of lagoon design
    - a. Considering depth
    - b. Determining area necessary for storing effluent
    - c. Identifying characteristics of lagoon bottoms
        - (1) Level
        - (2) Resistant to seepage
    - d. Identifying characteristics of dikes
        - (1) Watertight
        - (2) Wide enough for maintenance work
        - (3) Adequate freeboard
        - (4) Adequate inner and outer side slope
        - (5) Keeping surface water out
    - e. Identifying characteristics of inlet equipment and materials
        - (1) Pipe size, shape and quality of materials
        - (2) Pumps
        - (3) Structure of pipes
    - f. Identifying characteristics of shorelines
        - (1) Regular in shape
        - (2) No shallow areas
    - g. Identifying characteristics of outlet equipment and materials
        - (1) Pipe size, shape and quality of materials
        - (2) Structures of channels
        - (3) Pumps

Examples of Supporting References:

In addition to supporting references discussed in Student Performance Objective 1, the following may be found useful:

1. Manual of Wastewater Operations. Texas Water Utilities Association. Texas State Department of Health. Austin, Texas. 1971.

2. Wastewater Treatment Plant Operator Training Course Two. Water Pollution Control Federation. WPCF Publication No. 14. Washington, D.C. 1967.

Examples of Student Learning Activities:

1. The instructor may have blue prints of a local storage lagoon and ask several students to discuss the depth of the water storage in relationship to the design purpose.
2. The instructor may ask several students to design a water storage lagoon dike with the appropriate inner slope.
3. Given a diagram of a water storage lagoon, the instructor may ask several students to locate an inlet pipe in the appropriate place on the diagram.

Examples of Evaluation Techniques:

1. Given a storage lagoon bottom to be designed, the student should be able to identify two characteristics in design which must be considered.
2. Given the amount of wastewater to be stored over a one year period, the student should be able to determine the area and depth of storage lagoon necessary for proper storage and biological activity, to the satisfaction of the instructor.

Instructional Resources:

1. Access to a storage lagoon
2. Blueprints of a storage lagoon, including design of dikes, inlet and outlets
3. Diagrams of a storage lagoon system

Student Performance Objective 3:

While working in a wastewater treatment system, the student will operate and maintain a storage lagoon according to management request so that the system operates effectively, and is safe for working and attractive to visitors.

Instructional Areas:

1. Controlling water level
    a. Determining level for proper operation
    b. Lowering level for winter storage
    c. Raising the level for spring and summer release
    d. Checking water levels at various times

2. Controlling weeds
    a. Applying herbicides
        (1) Selecting equipment
        (2) Selecting herbicides
        (3) Measuring and mixing herbicides according to manufacturer's directions
        (4) Applying herbicides according to manufacturer's directions
        (5) Using safety practices
    b. Cutting weeds growing in the lagoons
        (1) Selecting the appropriate equipment for removing weeds
        (2) Using appropriate equipment to remove the weeds
        (3) Removing weeds from the lagoon
3. Controlling mosquitos
    a. Applying insecticides
        (1) Selecting equipment
        (2) Selecting insecticides
        (3) Measuring and mixing insecticides according to manufacturer's directions
        (4) Applying insecticides according to manufacturer's directions
    b. Removing organic matter from the water
        (1) Selecting equipment for cleaning
        (2) Cleaning organic matter out of the lagoon
        (3) Cleaning up the cuttings with appropriate equipment
        (4) Using safety procedures
4. Controlling erosion
    a. Selecting and using appropriate equipment in planting short-rooted grass
    b. Selecting and using appropriate equipment in improving soil on the dikes
    c. Selecting and using the appropriate equipment and materials in patching minor erosion
    d. Using feasible techniques in diverting surface water away from dikes

5. Controlling burrowing animals
    a. Selecting and using appropriate equipment and materials in repairing damage
    b. Consulting with a wildlife agency for control of the animals

Examples of Supporting References:

Supporting references were discussed in Student Performance Objectives 1 and 2

Examples of Student Learning Activities:

1. The instructor and students may visit a storage lagoon and the students may estimate minimum and maximum levels at which the lagoon will operate efficiently and explain the reasons for their estimates.

2. The instructor may ask three students to select the appropriate herbicide to apply in a storage lagoon filled with cattail plants.

3. The instructor may ask two students to mix an insecticide for mosquito control on a storage lagoon.

4. The instructor may ask three students to repair a small gully that has developed in the dike of a storage lagoon.

5. The instructor may ask two students to visit the local conservation officer and report to the class the officer's recommendations for the control of muskrats in a storage lagoon.

Examples of Evaluation Techniques:

1. Given the task of calculating maximum wastewater level, the student should be able to calculate the maximum wastewater level of a given storage lagoon according to the design specifications of that lagoon.

2. Given the task of removing debris from a storage lagoon, the student should be able to select the appropriate equipment and clean debris out of a storage lagoon to the satisfaction of the instructor.

3. Given a minor erosion problem on the outer side of a dike in a storage lagoon, the student should be able to select the appropriate materials and repair the damage to the satisfaction of the instructor.

Instructional Resources:

1. Access to a wastewater storage lagoon
2. A herbicide and manufacturer's instructions for its' use
3. An insecticide and manufacturer's instructions for its' use
4. Access to herbicide and insecticide application equipment
5. Access to mowing equipment
6. Materials for measuring and mixing herbicides and insecticides
7. Access to equipment for cleaning debris from a storage lagoon
8. Materials for patching minor erosion on a storage lagoon dike
9. Phone number of local conservation officer
10. Access to equipment for making minor erosion repairs
11. Diagrams and blue prints of a storage lagoon

MODULE OF INSTRUCTION

CODE--01.99

IRRIGATING WITH EFFLUENT

Module Concept: Effluent from a wastewater system can provide essential nutrients for growing crops. A further benefit of using effluent in irrigating crops is that the soil can serve as a filter for removing various materials from the effluent and produce a high quality water that can be released into streams and lakes with few harmful effects on the ecology.

The purpose of this module is to depict for the instructor materials which should be covered so that the student will understand the benefits of using effluent in irrigating crops and how to operate sprinkler irrigation systems.

Prerequisities: Admission to the Environmental Technology Program is sufficient evidence of qualifications for entry into the course.

Module Goal: When this module of instruction is completed, the student will be able to understand the benefits of and be able to operate an irrigation system in spraying effluent on crops.

Student Performance Objective 1: Given access to a field crop being irrigated, the student will explain verbally or in writing the benefits and disadvantages of using effluent for irrigating crops according to local agronomic reports

Instructional Areas:

1. Identifying advantages of spraying effluent on crops
    a. Increasing soil fertility by:
        (1) Adding nutrients
        (2) Improving soil tilth with organic matter
        (3) Correcting excessive sodium conditions

b. Removing enteric organisms by:
    (1) Removing E. Coli
    (2) Removing bacteria

c. Removing metals and toxic elements by:
    (1) Uptaking toxic substances by plants
    (2) Uptaking toxic substances by chemical reaction
    (3) Rendering toxic compounds nontoxic

d. Removing pathogens by:
    (1) Decomposing over a period of time into harmless protein
    (2) Straining
    (3) Absorbing
    (4) Eating by predators

e. Protecting the crop by:
    (1) Providing water for crops
    (2) Preventing freezing

2. Identifying environmental disadvantages of spraying effluent on crops

a. Determining the effects on the soil
    (1) Building up of metals and total dissolved solids in the soil
    (2) Creating drainage problems

b. Determining the effects on the air
    (1) Aerosal drifts
    (2) Odor problems

c. Determining the effects on crops
    (1) Toxic to plants when concentrated over long periods of time
    (2) Toxic to animals which consume crops
    (3) Limiting the crops that can be grown

d. Determining effects on Public Health

    (1) Surviving pathogenic organisms do exist for varying periods of time in the soil
    (2) Existing chemical compounds causing problems in health
    (3) Propagating insects as vectors in disease transmission

  e. Determining effects on the ground water

    (1) Building up inorganic nitrogen
    (2) Leaching of nutrients
    (3) Leaching of organics and toxic compounds

Examples of Supporting References:

1. Pound, Charles E. and Ronald W. Crites. Wastewater Treatment and Reuse Volume II. Office of Research and Development, U.S. Environmental Protection Agency. Washington, D.C. A research report numbered EPA-660/2-73-006b. August 1973.

2. Sullivan, Richard H., Morris M. Cohn and Samuel S. Baxter. Survey of Facilities Using Land Application of Wastewater. U.S. Environmental Protection Agency: Washington, D.C. A report numbered EPA-430/9-73-006. July 1973.

3. Muskegon County, Michigan Wastewater Management System No. 1. Bauer Engineering Inc. A 15 page document giving a brief description of the Muskegon County Wastewater Treatment System. 1973.

4. Factors Involved in Land Application of Agricultural and Municipal Wastes. Agricultural Research Service. U.S. Department of Agriculture. National Program Staff. Soil, Water and Air Sciences. Beltsville, Maryland. July, 1974

Examples of Student Learning Activities:

1. The instructor may ask several students to test effluent that is being irrigated on corn for nitrogen content.

2. The instructor may ask three students to prepare a report for the class on a list of at least three organisms in the soil which came from wastewater and their reported survival time in the soil.

3. The instructor may ask several students to draw a diagram and explain the nitrogen cycle in the soil.

4. The instructor may have three students prepare a report on the effects of various amounts of irrigation wastewater on corn at various stages of the growing season.

Examples of Evaluation Techniques:

1. The student should be able to list at least three soil nutrients that can be obtained by irrigating with wastewater effluent.

2. The student should be able to explain to the satisfaction of the instructor at least two ways pathogenic organisms are killed in the soil.

3. The student should be able to explain the benefits of irrigating effluent on corn in terms of yield changes to the satisfaction of the instructor.

Instructional Resources:

1. Soil testing kits
2. Appropriate equipment and reagents for testing nitrogen in water
3. Diagrams of nitrogen cycle in the soil
4. Pamphlets on irrigation of field crops
5. Pamphlets on soil fertility and crop nutrient requirements

Student Performance Objective 2:

Given access to effluent sprinkler irrigation equipment, the student will identify the components and verbally describe their functions according to the manufacturer's manual.

Instructional Areas:

1. Identifying the pivot components of sprinkler irrigation equipment and their functions
    - a. Wiring
    - b. Water supply
    - c. Collector ring
    - d. Pivot rotating assembly
    - e. Pressure gauge
    - f. Alignment and safety wires
    - g. Pivot control panel
2. Identifying the tower components and functions
    - a. Drive shaft
    - b. Pipe and tower base
    - c. Gearboxes
    - d. Electrical wires
    - e. Electrical boxes
    - f. Micro-switch arm
    - g. Tires and wheel
    - h. Couplers
    - i. Expansion chambers
3. Identifying piping features and functions
    - a. Flanges
    - b. Pipes
    - c. Electrical cables
    - d. Nozzles and drains
    - e. End boom cable

Examples of Supporting References:

1. Lockwood Waste Water Spray Irrigation System. Operators Manual. Maintenance . . . repair parts. Muskegon, Michigan.

Examples of Student Learning Activities:

1. Given a sprinkler irrigation rig, the instructor may ask several students to identify and explain the function of the alignment and safety wires.
2. Given a nozzle, the instructor may ask several students to disassemble and identify the components of the nozzle assembly.

Examples of Evaluation Techniques:

1. The student should be able to identify the pivot and point out at least four main components by name.

2. Given a pipe flange, the student should be able to explain its' function to the satisfaction of the instructor.

Instructional Resources:

1. Access to a sprinkler irrigation system
2. Individual components of a sprinkler irrigation system
3. Operator's manual to the sprinkler irrigation system

Student Performance Objective 3:

Given access to effluent sprinkler irrigation equipment, the student will operate the equipment according to the operator's manual

Instructional Areas:

1. Starting sprinkler irrigation equipment

    a. Checking micro-switch
    b. Checking levers and alignment cables for freedom of operation
    c. Checking all bolts for tightness
    d. Running water for about 10 minutes at recommended level to check for obstructions
    e. Turning on the spray system
    f. Checking control panel for lights as a check on proper operation

2. Turning off sprinkler irrigation equipment

    a. Locating controls and turning off
    b. Checking trouble lights

3. Starting sprinkler irrigation system after storage

    a. Checking micro-switches
    b. Checking levers and alignment cables
    c. Inspecting contactors in the magnetic starters at pivot panel, tower panels and end panel

d. Inspecting pivot panel, intermediate panels, end panel and gear motor junction box for loose wire connections

e. Checking all screws in starter assembly and terminal block for secure connections

f. Opening valve at end of the system and flushing until water is clear

g. Operating water flow 10 minutes to check for obstructions in the system

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1

Examples of Student Learning Activities:

1. The instructor and students may visit an operational sprinkler system and the instructor may ask several students to check the bolts for tightness on the sprinkler irrigation system

2. While visiting the sprinkler irrigation system, the instructor may ask several students to identify and explain the meaning of the trouble lights in the control panel.

3. The instructor may ask three students to demonstrate the appropriate steps which should be followed in turning on the sprinkler irrigation system.

4. The instructor may ask two students to mechanically flush the sprinkler system until the water is clear.

Examples of Evaluation Techniques:

1. The student should be able to check the alignment cables for tightness to the satisfaction of the instructor.

2. The student should be able to locate and explain the purpose of the trouble lights to the satisfaction of the instructor.

3. The student should be able to turn on the sprinkler irrigation system by following the manufacturer's recommended procedures.

Instructional Resources:

1. Access to an operational sprinkler irrigation system
2. Operator's manual for the sprinkler irrigation system
3. Appropriate tools for checking tightness of bolts

Student Performance Objective 4:

Given access to effluent sprinkler irrigation equipment and service equipment, the student will service the equipment according to the manufacturer's specifications.

Instructional Areas:

1. Establishing a lubrication schedule according to the operator's manual

    a. Using servicing records
    b. Using servicing manuals

2. Lubricating sprinkler irrigation equipment

    a. Identifying parts to be lubricated with the use of the service manual
    b. Selecting lubricants and lubrication equipment
    c. Lubricating the equipment
    d. Storing the lubricants and lubrication equipment

3. Servicing the gearbox

    a. Selecting the appropriate oil for the gearbox
    b. Changing the oil in the gearbox
    c. Keeping service records

4. Checking all bolts on the sprinkler irrigation system and tightening as necessary

5. Servicing the electrical systems

    a. Checking at frequent intervals to be sure all connections are tight

b. Checking panels for dirt, foreign matter and condensation
c. Checking the contacts in the starter assembly for burrs or foreign matter

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and student may visit a sprinkler irrigation system and have the student identify the grease fittings to be lubricated on the pivot.

2. The instructor may obtain a service manual for the sprinkler irrigation equipment, and have a student select the appropriate lubricant from the manual specifications.

3. The instructor may have three students change the oil in a gearbox.

4. The instructor may have several students inspect the electrical system on irrigation equipment for a build up of dirt.

5. The instructor may have several students check the contacts on the starter assembly for burrs.

Examples of Evaluation Techniques:

1. Given appropriate lubricants and lubricating equipment, the student should be able to lubricate the rotating assembly on the pivot according to manufacturer's specifications.

2. Given the appropriate tools, the student should be able to check and tighten bolts on the wheel lug to the satisfaction of the instructor.

3. The student should be able to present a report to the class on the use of recommended lubricants to be used in the gearbox to the satisfaction of the instructor.

Instructional Resources:

1. Access to an effluent sprinkler irrigation system
2. Appropriate lubricants and lubricating equipment
3. Service manual for irrigation equipment
4. Appropriate tools for servicing irrigation equipment

Student Performance Objective 5:

Given access to effluent sprinkler irrigation equipment and repair tools, the student will troubleshoot and make minor repairs on the equipment according to manufacturer's procedures and directions.

Instructional Areas:

1. Identifying reasons system does not operate properly and making repairs
    a. Checking 3-phase power and correcting incoming power supply
    b. Checking main and control fuses and repairing short circuit
    c. Checking control transformer and replacing when defective
2. Identifying reasons end tower does not move and making repairs
    a. Reversing contactor in panel and cleaning contact points
    b. Checking percentage time and replacing when defective
    c. Checking for loose or broken wires and repairing when necessary
    d. Checking end tower starter and cleaning contacts
    e. Checking motor and replacing when defective
    f. Checking drive train and repairing or replacing when defective
3. Identifying reason system will not hold in after starting and making repairs
    a. Checking alignment, locating source and repairing
    b. Checking overwatering shutdown and running in opposite direction

   c. Checking shutdown option and repairing when defective
   d. Checking safety circuit and replacing when defective

4. Identifying reasons end tower runs continuously

   a. Checking for defective timer and replacing rotor in motor when defective
   b. Checking for shorted wire in end tower circuit and repairing shorted wire.

5. Identifying reasons an intermediate tower does not move and making the repairs

   a. Checking alignment switch in tower and replacing when defective
   b. Checking over-load relay in motor and replacing when defective
   c. Check for motor single-phasing and repairing when equal voltage is not present
   d. Checking for drive train jamming or broken and repairing or replacing

6. Identifying reasons an intermediate tower runs continuously and making repairs

   a. Checking alignment switch in tower and replacing when defective
   b. Checking alignment mechanism for sticking and freeing or replacing when sticking

   c. Checking alignment wires for contacts and tightening tension on wire and stretch on spring

7. Identifying reasons system will not reverse by checking interlockings for closing and disassembling for cleaning

8. Identifying reasons safety fails to shut down machine and making repairs

   a. Checking for good contact of safety wires and repairing where defective
   b. Checking for loose safety wires and tightening wire to appropriate tension

  - c. Checking feedback through pump control circuit and repairing pump controller when defective
  - d. Checking neutral wire connection to ground and correcting when not correct
  - e. Checking safety transformer for correct connections and correcting where improperly connected

9. Repairing flat tires

  - a. Removing tire
  - b. Locating appropriate patching materials
  - c. Patching the tire
  - d. Replacing the tire on the rig

Examples of Supporting References: Examples of supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may have several students locate the main fuse box in a sprinkler system and change a fuse.

2. The instructor may ask two students to repair a broken electrical wire that is commonly found in a sprinkler irrigation system.

3. When a sprinkler irrigation rig has stopped due to being out of alignment, the instructor may have three students check for alignment and make the necessary corrections.

4. The instructor may have two student demonstrate the appropriate procedures to use for checking a shorted wire in the end tower circuit.

5. Given an intermediate tower in a sprinkler irrigation rig which continues to run, the instructor may ask three students to trouble shoot for the cause and correct it.

6. The instructor may ask three students to repair a broken drive train in a sprinkler irrigation rig.

7. The instructor may ask several students to disassemble and clean the reversing contactor in a sprinkler irrigation system control panel.

8. The instructor may give several students volt meters and ask them to check for electrical feedback in the pump control circuit.

Examples of Evaluation Techniques:

1. The student should be able to change a fuse in a control fuse box to the satisfaction of the instructor.

2. The student should be able to check the starter on the end tower and clean the contacts or corrosion to the satisfaction of the instructor.

3. The student should be able to locate and repair a short in the electrical system of a sprinkler irrigation system to the satisfaction of the instructor.

4. The student should be able to replace a rotor in the timer to the satisfaction of the instructor.

5. The student should be able to disassemble, repair and reassemble the drive train in a sprinkler irrigation rig to the satisfaction of the instructor.

6. The student should be able to replace a defective alignment switch to the satisfaction of the instructor.

7. The student should be able to tighten alignment wires on the sprinkler irrigation rig to 150 lbs. tension.

8. The student should be able to measure the voltage on the neutral wire with accuracy within 2 volts.

Instructional Resources:	1. Access to an operational sprinkler irrigation system 2. Appropriate tools for making repair on the irrigation system 3. Voltage meter 4. Service manual for the irrigation system 5. Appropriate materials for repairing broken electrical wires 6. Fuses and fuse puller 7. Spare parts such as rotors and alignment switches

MODULE OF INSTRUCTION

CODE--01.99

COLLECTING WASTEWATER SAMPLES

Module Concept: Correct sampling procedures must be followed in order to obtain representative samples. Representative samples are tested in the laboratory to determine the quality of effluent in various stages in treating waste. Laboratory test results must be kept on file to improve plant operations and for inspection by local, state and federal regulatory agencies. The sample must be small enough to be conveniently handled and large enough to be representative. Nothing must be lost or added before the laboratory test of the sample is made.

The purpose of this module is to assist the teacher in identifying the areas which should be taught so that the student will be able to accurately take a representative sample from various processes in wastewater treatment systems.

Prerequisites: Admission in the Environmental Technology Program is sufficient evidence of qualifications for entry into the course.

Module Goal: When this module of instruction is completed, the student will be able to accurately collect samples of water and wastewater.

Student Performance Objective 1: Upon completion of receiving instruction on pertinent information, the student will explain verbally or in writing the importance of accurately collecting samples of wastewater in a wastewater treatment system according to reference materials

Instructional Areas:

1. Identifying the reasons for sampling
    a. Using grab sampling
        (1) Adjusting chlorine dosage
        (2) Changing plant operations
        (3) Searching for undesirable constituents

        (4) During short duration operations as a check
        (5) Adjusting for high degree of instability of the water to be treated

    b. Determining reasons for using composite sampling

        (1) Doing routine analysis
        (2) Meeting legal requirements

2. Determining the importance of accurate sampling

    a. Having accurate information regarding the change in strength and quantity of untreated and treated waste from day to day and hour to hour

    b. Preventing valid legal questioning relative to method of sampling collection

Examples of Supporting References:

1. Wastewater Treatment Plant Operator Training Course Two. Water Pollution Control Federation WPCF Publication No. 14. Washington, D.C. 1967. pp. 101-104.

2. Operation of Wastewater Treatment Plants. Water Pollution Control Federation. WPCF Manual of Practice No. 11. Washington, D.C. 1970. pp. 188-192.

3. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering. Sacramento State College, 1970. Chapter 13.

4. Manual of Instruction for Sewage Plant Operators. Health Education Service. P.O. Box 7283. Albany, New York. 12224. pp. 127-130.

Examples of Student Learning Activities:

1. The instructor and students may visit a wastewater treatment system, and the students may examine records of temperature and daily flow and explain why it is necessary to test the flow of effluent prior to changing the plant operations.

2. The instructor may have several students research and report laboratory tests which must be performed by a wastewater treatment system according to requirements in a given state.

Examples of Evaluation Techniques:

1. The student should be able to explain at least three reasons a grab sample may be taken.

2. Given a thermometer, the student should be able to take the temperature of a water sample and read the temperature with 95% accuracy.

Instructional Resources:

1. Access to a wastewater treatment system
2. Information relative to required laboratory tests which must be performed by wastewater treatment systems in different states.

Student Performance Objective 2:

Given the task of collecting wastewater samples the student will select and use appropriate sampling equipment in collecting samples according to correct procedures in appropriate reference manual

Instructional Areas:

1. Identifying sampling equipment and their uses

    a. Long-handled dipper
    b. Weighed bottle or metal container for depth samples
    c. Hand pump with flexible suction
    d. Glass or plastic tubes
    e. Dissolved oxygen sampler
    f. Sterile bottles
    g. Automatic sampling equipment

2. Considering factors in using specified sampling equipment

    a. Location of the place from which sample is to be taken
    b. Type of sample required

3. Determine areas where samples are collected

    a. Raw wastewater
    b. Aerator
    c. Settling tank
    d. Storage lagoons
    e. Chlorinated effluent
    f. Receiving waters

4. Determining when to sample
    a. Identifying frequency on the basis of test requirements
    b. Sampling when unusual characteristics appear
    c. Sampling to meet regulatory requirements

5. Preparing for sample collection
    a. Studying the area
    b. Preparing area sketch
    c. Identifying safety procedures and hazardous conditions
    d. Wearing appropriate clothing
    e. Removing manhole covers, gates and opening doors
    f. Erecting safety barriers where necessary
    g. Selecting sampling equipment
    h. Preparing and labeling sample containers
    i. Preparing sample data sheets

6. Collecting samples
    a. Taking sample from appropriate depth and area with appropriate equipment
    b. Transfering sample to container
    c. Adding acid for preservation of a sample aliquot
    d. Sealing the sample containers
    e. Storing the sample containers
    f. Collecting for compositing
    g. Reading and recording flow data
    h. Transporting samples
    i. Refrigerating

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may ask several students to label several sampling containers

2. The instructor may ask several students to select the appropriate clothing to wear while taking a sample from the aerator.

3. The instructor may ask several students to sterilize a bottle with the appropriate equipment and chemicals before collecting a sample of wastewater.

4. While visiting a storage lagoon, the instructor may ask several students to explain the correct location and depth to take a grab sample.

5. Given access to a river, the instructor may ask several students to take a sample of water using a long-handled dipper.

6. The instructor may give collected samples to several students and have students transport the samples to the laboratory and store in appropriate places for later testing.

Examples of Evaluation Techniques:

1. Given appropriate sterilizing equipment and reagents, the student should be able to sterilize a sampling bottle to the satisfaction of the instructor.

2. With the need of collecting a sample for testing, the student should be able to select the appropriate sampling equipment and collect a sample from a small stream to the satisfaction of the instructor.

3. Given acid to be poured in a collected sample that is in a bottle container, the student should be capable of pouring acid in the bottle without spills to the satisfaction of the instructor.

Instructional Resources:

1. Access to a wastewater treatment system
2. Boots, coats and gloves
3. Sampling bottle containers and labels
4. Long-handled dipper
5. Acid for sample preservation
6. Measuring tape
7. Hand pump with flexible suction
8. Dissolved oxygen sampler
9. Equipment and reagents to sterilize bottles

MODULE OF INSTRUCTION

CODE--01.99

KEEPING RECORDS AND WRITING REPORTS IN WASTEWATER TREATMENT SYSTEMS

Module Concept: Keeping records and writing reports are valuable tools which must be performed accurately by Wastewater Treatment personnel. The personnel must be able to communicate with management and the public on the operation of their plants. Records and reports are also essential as a basis for supporting requests for additional plant equipment and facilities. Records are further used in showing the efficiency of the various treatment processes in determining changes in processes or chemical application and are used to determine whether the plant, state and federal requirements are met.

The purpose of this module is to depict for the instructor areas which should be taught relative to keeping records and writing reports so that the student will be able to effectively perform such tasks.

Prerequisites: Admission to the Environmental Technology program is sufficient evidence of qualifications for entry into the course. Studying modules which cover various waste treatment processes would be helpful in understanding this module.

Module Goal: When this module of instruction is completed the student should be able to maintain adequate records in a wastewater treatment system and accurately write reports.

Student Performance Objective 1: Given access to the records of a wastewater treatment system, the student will organize, maintain, locate and evaluate records so well that information can be located when needed in a reasonable period of time and the performance of the operation accurately determined.

Instructional Areas:

1. Determining reasons and implications for keeping records.
    a. Using records for determining daily plant efficiency
    b. Using records for determining type and frequency of maintenance and effectiveness of maintenance programs

- c. Using records as a basis for recommendations on modifying plant operations and facilities
- d. Using records for future designing and plant expansion
- e. Supporting budget requests
- f. Using records in damage suits
- g. Providing appropriate records for regulatory agencies
- h. Providing data for preparation of reports

2. Identifying the types of records and their uses:

   a. Determining the type of information required in operational records

      - (1) Recording of influent which comes into the plant
      - (2) Recordings relative to quality of influent and effluent (e.g. chemical, physical and bacteriological characteristics)
      - (3) Recording amount of electrical power used
      - (4) Recording the amount of chlorine used
      - (5) Recording unusual happenings such as bypasses, floods, storms and other events that may occur

   b. Determining plant and stock inventory by recording:

      - (1) Contract and "built in" plans and specifications which include detailed wiring and piping details
      - (2) Plant and operating instructions for plant equipment
      - (3) Costs of major equipment and unit items
      - (4) Each item of major equipment with manufacturer and identifying code numbers
      - (5) Lists of tools, materials and chemicals, laboratory reagents and supplies
      - (6) Log for each operation in the plant and expected time of completion of the treatment process in each operation

   c. Determining the types of maintenance records necessary:

      - (1) Length of operating time of pumps and motors
      - (2) Kilowatt hours used by each pump and motor
      - (3) Records of maintenance performed

d. Determining the types of financial or cost records such as:

    (1) Expenses
    (2) Purchases

e. Determining the types of personnel records that are necessary which include:

    (1) Annual performance rating
    (2) Salary
    (3) Vacation and sick time

3. Determining frequency of recording

    a. Daily
    b. Weekly
    c. Monthly

4. Maintaining records

    a. Identifying and selecting appropriate type of forms for recording
    b. Selecting locations for keeping daily recordings
    c. Writing data in appropriate columns in the following manner:

        (1) Writing in ink or indelible pencil
        (2) Writing complete information
        (3) Writing accurately

5. Locating records

    a. Determining methods for filing and their uses

        (1) Subject matter
        (2) Alphabetical
        (3) Chronological
        (4) Numerical

    b. Identifying various types of filing equipment
    c. Selecting and arranging files in a given location
    d. Filing information
    e. Locating needed information

6. Evaluating records

    a. Reviewing records for efficiency of operation
    b. Comparing past records to evaluate present performance

c. Using to support budget requests
d. Providing actual data for reports

Examples of Supporting References:

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970. Chapter 17.

2. Manual of Instruction for Sewage Treatment Operators. Health Education Service. P.O. Box 7283. Albany, N.Y. 12224. Chapter 12.

3. Operation of Wastewater Treatment Plants. Water Pollution Control Federation. WPCF Manual of Practice No. 11. Washington, D.C. pp. 160 ff.

Examples of Student Learning Activities:

1. The instructor may have several students accompany a wastewater treatment operator for one day and collect a set of records for the day.

2. The instructor may obtain copies of log sheets from a wastewater plant and ask several students to analyze the records and report to the class the changes in the treatment operation for the period the log covers.

3. The instructor and students may visit a wastewater treatment system and have the students record on a sample log sheet given to each of them the amount of chlorine used the previous day. This information could be obtained from the operational log sheet of the chlorine system.

4. The instructor may ask two students to make an inventory of a workshop, listing all major materials, tools and supplies.

5. While visiting a wastewater treatment system, the instructor may ask several students to read the gauges on the motors, and by comparing the daily log of operating time for the day, report the number of hours the pump had operated up to the time the visit was made.

6. While working in the office of a wastewater treatment system, the employer may ask the student to go to the appropriate file and locate the personnel file on a given person.

Examples of Evaluation Techniques:

1. When placed in a wastewater treatment system, the student should be able to complete log sheets along with an operator for one day's operation to the operator's satisfaction.
2. Given the task of taking inventory, the student should be able to complete an inventory of a workshop to the satisfaction of the instructor.
3. The student should be able to read, calculate and record the number of kilowatts used by a pump in a specified period of time to the satisfaction of the instructor.

Instructional Resources:

1. Access to an operational wastewater treatment system
2. Sample log sheets and clip board
3. Access to a workshop area
4. Ink pen or indelible pencil

Student Performance Objective 2: Given the task of writing and presenting a technical report of a wastewater treatment system, the student will organize, write and present a report so well that the report is accurate and understood by listeners.

Instructional Areas:

1. Identifying the purposes of a report
    a. Serving as a basis for request for funds
    b. Serving as a basis for changes in plant operations or personnel
    c. Serving as a means of communicating the abilities of the operator to management
    d. Meeting the requirements of management and regulatory agencies
2. Identifying types of reports
    a. Daily reports which include unusual events

b. Monthly plant operation reports which include:
   (1) Plant effectiveness
   (2) Cost data
   (3) Maintenance records
   (4) Unusual significant events during the month
   (5) Effect on receiving waters
   (6) Conclusions and recommendations

c. Reports required by regulatory agencies such as local or state Health Department or the Environmental Protection Agency

d. Quarterly or annual reports for management which include:
   (1) Compilation of data from monthly reports
   (2) A summary of yearly efficiency and cost
   (3) Recommendiatons for next year's operation
   (4) Organizational chart
   (5) Conclusions

3. Identifying the principles of report writing
   a. Knowing the purpose of the report
   b. Tailoring the report to persons to whom it is directed
   c. Knowing the subject
   d. Organizing the report
   e. Using language that will be understood by the reader
   f. Using facts and figures
   g. Being exact and brief
   h. Writing effectively

4. Organizing the report to include some of the following
   a. Brief statement of the problem
   b. Body of the report
      (1) Technical and administrative background
      (2) Investigation details
      (3) Necessary supporting materials
      (4) Appendix
   c. Conclusions and recommendations
   d. Summary

5. Writing a report by following a process such as:
   a. Listing ideas and topics to be covered

b. Arranging ideas in a logical sequence
c. Gathering supporting materials
d. Writing a rough draft
e. Preparing conclusions and recommendations
f. Reviewing the preliminary draft for:

    (1) Content
    (2) Logical presentation
    (3) Unnecessary information

g. Reviewing for sentence structure, spelling, grammar and briefness
h. Rewriting a second draft
i. Having second draft reviewed by an appropriate person
j. Reviewing for overall effectiveness

6. Using illustrating material in the report such as:

    a. Sketches and drawings
    b. Pictorial drawings
    c. Diagrammatic representations
    d. Graphs
    e. Photographs

7. Submitting technical reports to appropriate individuals or agencies

8. Presenting an oral technical report

    a. Using appropriate materials for delivering speech
    b. Delivering speech

        (1) Giving introductory statement
        (2) Using correct posture
        (3) Speaking clearly
        (4) Using gestures to convey ideals
        (5) Keeping audience interested
        (6) Summarizing the report

    c. Answering questions

Examples of Supporting References: Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may have on hand samples of several different reports and ask students to read at least 3 of them and describe the purpose each report seems to be fulfilling.

2. The instructor may have several students visit an open meeting of a wastewater treatment system and report to the class the types of reports presented during the meeting.

3. The instructor may ask several students to interview local Health Department personnel and report the kinds and frequency of reports required of their department from the wastewater treatment system.

4. The instructor may ask several students to visit a wastewater treatment system and after interviewing the operator, prepare a report on the types of records that are maintained by the wastewater treatment operator on a daily basis.

5. After removing all the illustrated materials, the instructor may give the students an annual report of a wastewater treatment operation, and ask three students to suggest illustrated material that would make the report more interesting and easier to read.

6. Have students prepare and present a technical report relating to treating waste to the class.

Examples of Evaluation Techniques:

1. The student should be able to list and explain at least 5 principles that should be considered in writing a report.

2. The student should be able to demonstrate the use of at least 6 steps to take in the actual writing of a report.

3. The student should be able to write a report of a visit of one day he/she had with the wastewater treatment operator to the satisfaction of the instructor.

4. Given a report without illustrated materials, the student should be able to read the report and suggest several illustrated materials that would clarify and aid in the brevity of the report to the satifaction of the instructor.

Instructional Resources:

1. Access to a wastewater treatment system
2. Samples of several reports, which should include daily, monthly and annual reports of various types.
3. Access to local Health Department personnel
4. Examples of illustrated material that could be used in reports. These could include sketches, drawings, pictorial drawings, graphs and photographs
5. Several technical reports

MODULE OF INSTRUCTION

CODE--01.99

USING PUBLIC RELATIONS IN WASTEWATER LAND TREATMENT SYSTEMS

Module Concept: Public relations are essential in the operation of wastewater treatment systems primarily because the community needs to be aware of how domestic and industrial wastes are treated and reused.

The purpose of this module is to provide the instructor with areas which should be taught so that individuals desiring to work in wastewater treatment systems will have the ability to plan, organize, conduct and evaluate various public relations activities relating to the operation of wastewater treatment systems.

Prerequisites: Admission in the Environmental Technology Program is sufficient evidence of qualifications for entry into the course. Relevant courses in English and Public Speaking would also be helpful.

Module Goal: When this module of instruction is completed, the student should be able to organize and conduct various effective public relations activities.

Student Performance Objective 1: Given the task of showing and explaining the wastewater treatment system to a group the student will plan and conduct the tour so well that the tour is conducted in a safe and organized manner and the visitors clearly understand the system after touring.

Instructional Areas:

1. Planning a tour
    - a. Determining where and when tour is to be held
    - b. Contacting persons in charge of operations
        - (1) Identifying number of persons desiring to tour site
        - (2) Establishing starting and ending time for tour
        - (3) Collecting information pertinent to the operations
        - (4) Observing facilities and establishing tour route

        - (5) Identifying hazardous conditions

    - c. Arranging for transportation
    - d. Preparing note cards
    - e. Discussing the need for neat appearance of the site and safety with individuals on the site

2. Conducting the tour
    - a. Counting number of persons desiring to take tour
    - b. Making instructions
    - c. Using audio-visual materials and equipment
    - d. Presenting visitors with appropriate clothing
    - e. Touring the site
        - (1) Explaining the operations verbally
        - (2) Pointing out major aspects in the operation
        - (3) Answering questions
        - (4) Preventing injuries
        - (5) Stimulating interest of visitors

3. Completing tour
    - a. Making summary statements
    - b. Collecting and storing clothing used by visitors
    - c. Counting visitors to make sure all are accounted for
    - d. Verbally thanking visitors and individuals on the site for the tour
    - e. Writing and sending individuals on the site positive comments relative to the tour

Examples of Supporting References:

1. Public Relations for Water Pollution Control. Water Pollution Control Federation. WPCF Manual No. 12. Washington, D.C. 1965

2. Wastewater Treatment Plant Operator Training Course One. Water Pollution Control Federation. WPCF Publication No. 13. Washington, D.C. 1970.

Examples of Student Learning Activities:

1. The instructor may ask several students to conduct a tour of a wastewater treatment system with other students acting as visitors.

2. The instructor may ask several students to verbally give an introduction with other students in the class acting as visitors.

Examples of Evaluation Techniques:

1. During a tour of a wastewater treatment system, the instructor may ask several students to individually and verbally explain the operation of the system at various specific places along the tour route to the satisfaction of the instructor.

2. While touring a wastewater treatment site, the instructor may ask several students to point out hazardous conditions that must be taken into account while conducting a tour to assure the safety of the visitors. This is to be done to the satisfaction of the instructor.

3. Given a slide projector and set of slides, the student should be able to operate the projector without damaging the projector or slides.

Instructional Areas:

1. Maps of wastewater treatment sites
2. Diagrams of wastewater treatment sites
3. Slide projector and appropriate screen
4. Access to a wastewater treatment site
5. Access to a community relations person at a local plant
6. Appropriate protective clothing
7. Set of slides

Student Performance Objective 2:

Given the task of preparing and presenting a speech, the student will prepare and present a speech on behalf of a wastewater treatment system so well that the speech is clear and understood by the listeners.

Instructional Areas:

1. Planning a speech
    a. Determining the topic to be covered
    b. Identifying the type of audience to whom the speech will be delivered
    c. Preparing an outline

2. Preparing a speech
    a. Researching topic
    b. Writing a rough draft
    c. Writing the final copy

3. Delivering a speech
    a. Arranging the place and date of a speech
    b. Arranging appropriate publicity for the speaker
    c. Arriving at the appropriate time
    d. Presenting the speech

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The student may visit an organization where a speech is presented and take notes on the speech and method of delivery.

2. The instructor may ask several students to prepare a speech on a topic of local interest concerning the wastewater treatment system.

3. The instructor may ask several students to present a speech of not more than 5 minutes in length to the class.

Examples of Evaluation Techniques:

1. Given a simulated occasion, audience and 3 topics by the instructor, the student should be able to select one topic and prepare an outline for a 5 minute speech to the satisfaction of the instructor.

2. Given an outline, the student should be able to write a 5 minute speech, to the satisfaction of the instructor.

3. Given a prepared speech, the student should be able to present the speech to the class to the satisfaction of the instructor.

Instructional Resources:

1. Several practical books or pamphlets on the preparation and delivery of speeches may be obtained from the English or Speech Department

2. Podium

Student Performance Objective 3:

Given the appropriate materials the student will prepare the following:

a. News releases
b. Bulletins
c. Newsletters
d. Photographs

Instructional Areas:

1. Preparing a news release

   a. Researching pertinent facts
   b. Determining when to release the material
   c. Writing a news release

      (1) Preparing an outline
      (2) Writing a rough draft
      (3) Editing the rough draft
      (4) Preparing the final copy
      (5) Including name, address and telephone number of the writer

2. Preparing bulletins and newsletters

   a. Keeping on file information which may be publishable
   b. Determining and identifying circulation list
   c. Writing a newsletter

      (1) Organizing the information
      (2) Reprinting articles with permission
      (3) Rough drafting
      (4) Preparing the final copy
      (5) Having the copy approved by a responsible person in the organization before printing

3. Preparing and using photographs

a. Locating and arranging for a photographer
b. Taking photos

    (1) Taking action shots
    (2) Taking appropriate number of photos
    (3) Determining names and titles of persons in the photographs

c. Retaining a supply of up-to-date photos

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may ask several students to prepare a news release covering a topic given by the instructor.

2. The instructor may ask several students to take several photos each with a camera supplied by the school.

3. The instructor may give the class several photos of a wastewater treatment site and ask several students to identify the positive characteristics of each photo.

4. The instructor may present to the class several news releases and ask the student to read them for content and interest.

Examples of Evaluation Techniques:

1. Given an item of local interest concerning the wastewater treatment sytem, the student should be able to write a news release to the satisfaction of the instructor

2. Given a bulletin, the student should be able to evaluate the contents for interest and appropriateness to the satisfaction of the instructor.

Instructional Resources:

1. Examples of news releases
2. Examples of bulletins and newsletters
3. Examples of public relations photos
4. Appropriate projector for showing photos

Student Performance Objective 4: Given the opportunity of working directly with the public, the student will communicate effectively with people through the use of the telephone, in personal conversations and mail corresponsdence so well that the content of the communications are clear and accurate.

Instructional Areas:

1. Using the telephone
    - a. Answering before the third ring
    - b. Identifying ones' self
    - c. Listening carefully to the caller
    - d. Keeping a pad of paper and pencil near the phone
    - e. Being friendly
    - f. Taking messages accurately
    - g. Answering calls promptly
    - h. Returning calls promptly
    - i. Using appropriate procedures in handling complaints
2. Using mail correspondence
    - a. Organizing a letter
        - (1) Salutation
        - (2) Body of letter
        - (3) Closing
    - b. Writing a correspondence letter
    - c. Using appropriate procedures in handling complaints
3. Working with individuals in personal conversations.
    - a. Making introductions
    - b. Being friendly
    - c. Being appropriately dressed
    - d. Listening attentively
    - e. Writing down complaints
    - f. Answering questions
    - g. Using appropriate procedures in handling complaints

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may arrange a simulated situation, using a model telephone, and may call several students to make a complaint regarding a nuisance at the wastewater treatment plant at which the student is working, to which the student should be able to appropriately reply.

2. The instructor may write a letter of inquiry concerning a wastewater treatment system and the students should be able to write a reply to that letter as employees in charge of answering mail.

3. Using simulated techniques, the student may do some role playing with one student acting as an employee of a wastewater treatment system and another coming in to make a complaint. Have the class members observe:

   a. The procedure for handling the complaint
   b. The way in which the students responded with words, tone and actions
   c. The success in handling the matter pleasantly

Examples of Evaluation Techniques:

1. Given a simulated situation, the student should be able to reply in writing to the satisfaction of the instructor.

2. Given a letter of complaint, the student should be able to reply in writing to the satisfaction of the instructor.

Instructional Resources:

1. Model Telephone
2. Samples of business letters
3. Sample list of complaints which the wastewater treatment personnel may receive
4. Paper and pencil

Student Performance Objective 5:

Given records to be filed, magazines and newspapers to be retained, the student will file records and articles and give reasons for filing information in certain sections so well that needed information can be located when needed and the filing of information meets the approval of the instructor.

Instructional Areas:

1. Identifying the procedures in a filing system.

    a. Determining methods for filing and their uses.

        (1) Subject matter
        (2) Alphabetical
        (3) Chronological
        (4) Numerical

    b. Identifying various types of filing equipment
    c. Selecting and arranging files in a given location

2. Understanding the reasons for filing information
3. Filing information
4. Locating needed information

Examples of Supporting References:

1. Public Relations for Water Pollution Control. Water Pollution Control Federation. WPCF Publication No. 12. Washington, D.C. 1965. pp. 46-53.
The instructor may also obtain books on filing from the Secretarial Sciences Instructor.

Examples of Student Learning Activities:

1. The instructor may invite a well-qualified secretary to discuss with the class methods of simple filing techniques.

2. The instructor may ask students to bring newspaper and magazine clippings about wastewater treatment and related fields and have the students organize a subject matter file.

Examples of Evaluation Techniques:	1. Given numerous newspaper clippings and letters, the student should be able to file them by subject matter in such a way that another student could locate them without difficulty and to the satisfaction of the instructor
	2. Given several files in a room to be organized, a student should be able to organize them in a room for efficient use to the satisfaction of the instructor.
Instructional Areas:	1. Access to a filing system 2. File folders 3. Filing equipment

MODULE OF INSTRUCTION

CODE--01.99

ACQUIRING AND USING GOOD HUMAN RELATION SKILLS WHILE WORKING IN WASTEWATER TREATMENT SYSTEMS

Module Concept: Success or failure on the job depends upon a person's ability to relate successfully with supervisors, subordinates, or fellow employees. Many jobs are lost because of poor human relations between employees in various job settings. It is important that employees recognize their good qualities and deficiencies in order to become more effective in working with people in the real world of work. Human relations is a "two-way street" in that the employee must be responsible and loyal to the employer and the employer must respect the ideals and skills of the employee. Individuals in a work setting must be willing to listen and exchange ideas during business and general conversations.

The purpose of this module is to provide the instructor with instructional areas which should be taught in order to assist the student in developing good human relations skills.

Prerequisites: No major prerequisites are required by the student to master this module. The student should be capable of reading and understanding basic literature.

Module Goal: Upon completion of this module, the student should be aware of the importance of acquiring and using good human relations skills while on the job.

Student Performance Objective 1: Upon completion of pertinent information, the student will identify several causes of failures on the job and some of the criteria employers use in advancing or promoting employees according to given employee handbook.

Instructional Areas:

1. Identifying common causes of job failure
   a. Causes related to personal appearance
   b. Causes related to personality
   c. Causes related to technical competencies
2. Identifying various personal appearance and personality traits and technical competencies which are generally accepted by employers
3. Recognizing various personal appearance and personality traits and technical competencies which affect human relations processes

Examples of Supporting References:

1. Human Relations in Agri-Business. East Lansing, Michigan: Department of Secondary Education and Curriculum, Michigan State University. 1969, 64 pages.
2. Human Relations in Agricultural Occupations. Module No. 3. Columbus, Ohio: The Center for Vocational and Technical Education, The Ohio State University. 1965, 31 pages.
3. Human Relations in Business. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University. 1971, 69 pages.
4. Resource Unit on Human Relations. Tucson, Arizona: Department of Agricultural Education, The University of Arizona. 1971, 90 pages.

Examples of Student Learning Activities:

1. Have students develop a questionnaire and survey local industries to determine major factors or reasons for individuals losing their jobs during the last three years.
2. The instructor may prepare or obtain a personal appearance form and have individual students evaluate themselves.

3. The instructor and students may invite a supervisor of a wastewater treatment system to visit with the class and discuss factors which prevent workers from advancing or loosing their job.

Examples of Evaluation Techniques:

1. Have students list at least 8 personal appearance factors one should possess in a work setting and explain their importance.
2. Have students list and explain several major reasons why employees do not advance in their work or lose their job.

Instructional Resources:

1. Personal Appearance Check Forms
2. Personality Traits Check Forms

Student Performance Objective 2:

In preparing to enter into an occupation in water and wastewater treatment systems, the student will be capable of explaining verbally or in writing the employee's role, employer's role and the supervisor's role according to duties of the various groups and to the satisfaction of the instructor.

Instructional Areas:

1. Assessing the employee's role on the job
    a. Working with employer
    b. Working with supervisors
    c. Working with fellow employees
    d. Communicating with visitors
2. Assessing the employer's role on the job
    a. Working with employees
    b. Working with Supervisors
    c. Communicating with visitors
3. Assessing the Supervisor's role on the job
    a. Working with owners
    b. Working with employees
    c. Working with other supervisors
    d. Communicating with visitors

Examples of Supporting References:

Supporting references were shown under Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and students may visit a local business and have the owner or manager explain and point out the importance of employees using good human relation skills on the job.
2. The instructor and students may invite an industry person who is in charge of personnel to discuss with the students personnel problems which usually occur on the job and explain alternatives for solving problems.

Examples of Evaluation Techniques:

1. The instructor may elect to have students list at least five problems which may occur in a work setting. Students should be capable of explaining alternatives for solving problems listed.
2. Given a problem and acting as plant manager, the student should be capable of solving the problem in a simulation exercise with involvement of other students to the satisfaction of the instructor.

Instructional Resources:

1. Visitation to a business and/or industry
2. Forms for evaluating job performance of employees

MODULE OF INSTRUCTION

CODE--01.99

MANAGING AND SUPERVISING EMPLOYEES IN WASTEWATER TREATMENT SYSTEMS

Module Concept: Good management and supervision are considered to be very important elements in the operation of wastewater treatment systems. Problems (i.e. personnel and equipment break downs) do arise in the operation of wastewater treatment systems; therefore managers and supervisors must be very competent in minimizing or resolving problems encountered.

The purpose of this module is to depict for the instructor areas which should be taught relative to using good management and supervisory techniques in working with employees in wastewater management systems.

Prerequisites: Admission to the Environmental Technology Program is sufficient evidence of qualifications for entry into the course.

Module Goal: When this module is completed, the student will be able to use good management and supervisory skills in working with wastewater treatment employees.

Student Performance Objective 1: Given the opportunity to participate in a simulated exercise prepared by the instructor, the student will demonstrate various recruiting techniques according to an approved recruiting technique manual.

Instructional Areas:

1. Advertising vacant positions
    a. Writing job descriptions
        (1) Determining duties to be performed
        (2) Establishing level of education needed
        (3) Determining work experience needed
        (4) Listing needed personal traits
        (5) Establishing wage/salary ranges
        (6) Establishing dates for accepting application

b. Posting vacant positions

    (1) Using local newspapers, trade magazines and employment agencies
    (2) Posting positions on site

2. Interviewing applicants

    a. Putting applicant at ease
    b. Having applicant fill out application
    c. Conducting the interview by determining:

        (1) Personal qualities
        (2) Academic achievement
        (3) Occupational experience
        (4) Interpersonal competence
        (5) Career desires

3. Using examination procedures when needed

    a. Administering tests
    b. Evaluating test results

4. Hiring the applicant

    a. Having the applicant fill out necessary forms

        (1) Insurance
        (2) Payroll deductions
        (3) Other

    b. Explaining plant functions and applicants' duties

    c. Training on the job

        (1) Receiving on the job training
        (2) Obtaining additional formal training
        (3) Attending technical meetings
        (4) Reading necessary journals, books and manuals

Examples of Supporting References:

1. Famularo, Joseph J. Handbook of Modern Personnel Administration. McGraw-Hill Book Company: N.Y. 1972.

Examples of Student Learning Activities:

1. Given the task of writing a job description for wastewater treatment maintenance personnel, the

instructor may have several students visit a wastewater treatment system, interview wastewater treatment maintenance personnel and write a job description for the given occupation.

2. In a simulated interview, the instructor may divide students in groups of two and have students conduct an interview in determining the educational and occupational background of an applicant for a job as wastewater treatment operator.

3. The instructor may have students fill out several payroll deduction forms.

Examples of Evaluation Techniques:

1. Given a job description for wastewater treatment operator, the student should be able to read the job description and determine the work experience and education required for the job.

2. Given an application, the student should be able to fill out an application for a job to the satisfaction of the instructor.

Instructional Resources:

1. Access to a wastewater treatment system and its' personnel
2. Payroll deduction forms
3. Application forms for a job
4. Examples of job descriptions
5. Insurance forms

Student Performance Objective 2:

Given the opportunity to participate in a simulation exercise prepared by the instructor, the student will demonstrate the appropriate techniques in controlling absenteeism so well that the techniques used meet the approval of the instructor.

Instructional Areas:

1. Determining reasons for employee absences

    a. Taking days off due to sickness in family
    b. Taking days off due to death in family
    c. Employees disgusted with fellow employees and work environment
    d. Becoming involved in fun days
    e. Taking time off for personal business

2. Preventing absenteeism
    a. Checking cause and recording on first absence
    b. Interviewing employees and taking to higher management for occasional unexcused absences
    c. Informing employee in writing with a final warning when several absences have occured

3. Controlling absenteeism
    a. Paying for unused sick leave on retirement
    b. Awarding additional paid sick time for good attendance
    c. Rewarding employees who are seldom absent

4. Providing due process for employee to be released

Examples of Supporting References:

In addition to the supporting references discussed in Student Performance Objective 1, the following may be useful:

1. Bittle, Lester R. What Every Supervisor Should Know. McGraw-Hill Book Company: N.Y. 1959.

Examples of Student Learning Activities:

1. The instructor and students may visit a plant personnel office and the personnel officer may show the students a personnel file of a person with absentee problems and explain what steps the company is taking to prevent further absenteeism.

2. The instructor may have several students draw up a policy to control absenteeism in a wastewater treatment system.

Examples of Evaluation Techniques:

1. Given the position as manager, the student should be able to list and explain at least two ways he/she would use to control absenteeism to the satisfaction of the instructor.

2. In a simulated exercise, the student should be able to write a warning notice to an employee who has taken an unexcused absence to the satisfaction of the instructor.

Instructional Resources:

1. Access to a personnel officer in a plant
2. Examples of personnel files
3. Examples of warning letters

Student Performance Objective 3:

Given the educational background and other measures used in establishing the salaries of two individuals working in the same job classification, the student will verbally explain salary variations and demonstrate appropriate ways in determining adequate salaries for job classifications with accurate calculations in determining salaries and the explanation meets the approval of the instructor.

Instructional Areas:

1. Identifying the various systems of the salary selection
    a. Using the ranking system by comparing jobs which are more difficult and important
    b. Grading system
        (1) Writing description for each job
        (2) Constructing a scale for each grade
    c. Point system
        (1) Measuring aspects for factors important to a group of jobs
        (2) Analyzing each job and comparing how much of each factor is present
    d. Factor comparison system
        (1) Selecting and defining factors
        (2) Ranking key jobs under each factor
    e. Market approach system
        (1) Surveying average wage for many jobs
        (2) Assigning salary range for each job
2. Determining reasons why higher salaries are needed for particular jobs
    a. Maintaining present employees
    b. Securing needed employees

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1 and 2.

Examples of Student Learning Activities:

1. The instructor may have several students survey the average wage for a wastewater treatment operator in at least two systems.

2. The instructor may ask students to form groups of three, and have each group compare jobs in a wastewater treatment system which are more difficult and more important and present pertinent information to the class.

Examples of Evaluation Techniques:

1. Given a job description of a lagoon operator, the student should be able to rank the job in comparison to the wastewater treatment operator to the satisfaction of the instructor.

2. The student should be able to conduct a salary survey among wastewater treatment personnel and assign a salary range for wastewater maintenance personnel based on the survey to the satisfaction of the instructor.

Instructional Resources:

1. Access to personnel in at least two wastewater treatment systems
2. Examples of job descriptions
3. Examples of salary ranges for wastewater treatment jobs

Student Performance Objective 4:

In a simulated wastewater treatment system exercise prepared by the instructor, the student will arrange work schedules for the required number of employees in the system so well that the task to be performed can be completed at a minimum cost and work schedule meets the approval of the instructor.

Instructional Areas:

1. Limiting work week to 40 hours

    a. Arranging work for employees during regular hours
    b. Assigning undesirable hours equitably

2. Planning the work schedule by considering:
    a. Holidays
    b. Vacations
    c. Rest periods
    d. Leaves of absence
    e. Training time
    f. Shift rotation
    g. Meal reliefs
    h. Quits and discharges
    i. Time off to vote
    j. Absences
    k. Taking employees personal problems into account

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may have three students study the absent list of a plant and explain several factors that would account for absences.

2. The instructor may ask three students to work out a one week schedule for three shifts per day for a total of 20 employees.

Examples of Evaluation Techniques:

1. The student should be able to list at least six factors to take into account when planning a work schedule.

2. The student should be able to work out a one week schedule for three eight hour shifts per day for a total of 20 employees to the satisfaction of the instructor.

Instructional Resources:

1. List of paid holidays commonly given to wastewater treatment employees.
2. Examples of work schedules of one week and one month for wastewater treatment systems.

Student Performance Objective 5:

In a simulated wastewater treatment exercise prepared by the instructor, the student will manage and supervise employees so that the task to be performed can be completed in a manner that the employees are satisfied with the supervision and work environment.

Instructional Areas:

1. Establishing priorities
    - a. Knowing what needs to be accomplished
    - b. Breaking down the job into steps or parts
    - c. Setting a time schedule for completing various tasks
    - d. Assigning parts of the job to those best suited to handle them
    - e. Following through to be sure all objectives are achieved
2. Planning the job
    - a. Defining the problem
    - b. Relating all the facts necessary
    - c. Sorting out the facts that are irrelevant
    - d. Weighting facts against several possible solutions
    - e. Reaching a tentative decision
    - f. Testing the plan
3. Delegating responsibility
    - a. Selecting capable employees
    - b. Giving accurate directions
    - c. Allowing employees some initiative
    - d. Checking on work without looking over the shoulder of the employee
4. Giving orders
    - a. Being concise and accurate
    - b. Making sure the worker thoroughly understands the instructions
    - c. Being authorative but not bossy
    - d. Expecting compliance
    - e. Checking back on tasks given
    - f. Letting no sloppy work get by
5. Supervising
    - a. Being objective and fair with each employee
    - b. Setting a good example
    - c. Keeping own personal problems out of supervisory decisions
    - d. Getting to know and respect each worker

Examples of Supporting References:

In addition to supporting references discussed in Student Performance Objectives 1 and 2, the following may be helpful:

1. Manual of Wastewater Operations. Texas Water Utilities Association. Texas State Department of Health, Austin, Texas. 1971

Examples of Student Learning Activities:

1. Given the task of breaking down a job into steps, the instructor may ask several students to list the steps required to inspect an aerator.
2. Given the simulated task of suggesting several possible solutions for a problem, the instructor may ask three students to inspect the erosion on a lagoon bank and suggest possible repairs.

Examples of Evaluation Techniques:

1. The student should be able to list at least four steps necessary in planning a job.
2. The student should be able to give an oral order to a fellow student to sweep a floor in such a way that that fellow student will accomplish the job accurately.

Instructional Resources:

1. Access to a wastewater treatment system
2. Broom and floor to sweep
3. Floor sweeping compound

MODULE OF INSTRUCTION

CODE--01.99

CONTROLLING INSECTS AND RODENTS IN WASTEWATER TREATMENT SYSTEM BUILDINGS

Module Concept: Insects and Rodents must be controlled because they will damage agricultural products, facilities and equipment. Insects and rodents are also capable of transmitting numerous diseases.

The purpose of this module is to provide the instructor with instructional areas which should be taught regarding the prevention and control of insects and rodents.

Prerequisites: In order to comprehend this module, the student should be capable of reading and comprehending basic literature.

Module Goal: When this module is completed, the student should be capable of using various techniques in preventing and controlling insects and rodents.

Student Performance Objective 1: Using the building facilities in a wastewater treatment system, the student will identify possible areas where insects and rodents are usually located and multiply to the satisfaction of the instructor, and so that chemical applications can be applied for controlling the pest.

Instructional Areas:

1. Identifying types of insects and rodents found in wastewater systems
    a. Determining types of insects and their growth characteristics
        (1) Filter flies
        (2) Housefly
        (3) Mosquito
        (4) Cockroach
        (5) All other biting dipterans found in wastewater treament systems
    b. Considering rats and their growth characteristics
2. Identifying areas where insects and/or rodents usually locate and multiply
    a. Checking the following areas in the building
        (1) Walls
        (2) Floors
        (3) Ceilings
        (4) Dressing rooms and lockers
        (5) Lunch rooms
        (6) Offices
        (7) Rest rooms

  - (8) Storage rooms
  - (9) Wastewater treatment laboratory
  - (10) Equipment

b. Checking the following areas around the building facilities in a wastewater treatment system

  - (1) Entrance to building facilities
  - (2) Garbage disposal
  - (3) Outside walls of buildings

Examples of Supporting References:

1. Fridline, Clarence R. Insecticides-Kinds, Formulation Mixing and Applying. Columbus, Ohio: Ohio Agricultural Education Curriculum Materials Service, The Ohio State University, 1973, 65 pages.

2. Texas Water Utilities Association, Manual of Wastewater Operations. Texas State Department of Health, Austin, Texas, 1971.

Examples of Student Learning Activities:

1. The instructor and students may desire to visit a wastewater treatment system and have several students identify various insects at the site.

2. The instructor may have several students explain the life cycle of the mosquito.

3. While visiting a wastewater treatment system, the instructor may have the plant manager or supervisor explain to students the essence of the plant's insect and rodent control program.

4. While visiting a wastewater treatment plant, the instructor may have several students identify areas where insects are usually located.

Examples of Evaluation Techniques:

1. Have students list at least five areas where insects are usually located and explain the conditions which cause them to multiply in wastewater treatment systems.

2. Have students explain the life cycles of mosquitos.

Instructional Resources:

1. Access to a wastewater treatment system
2. Diagrams which depict the life cycles of insects

Student Performance Objective 2:

Using insecticide and rodenticide applicator, the student will apply insecticides and rodenticides approved by the U.S. Department of Agriculture, according to the manufacturer's directions.

Instructional Areas:

1. Determining types of insecticides and rodenticides
    - a. Identifying the characteristics of fumigants used for controlling insects and rodents
        - (1) Hydrorganic acid gas
        - (2) Methyl bromide gas
    - b. Identifying the characteristics of insect sprays used for controlling insects
        - (1) Organic Thiocyanates
        - (2) Chordane
        - (3) Lindane
        - (4) Malathion
        - (5) Pyrethrin
        - (6) Allethrin
        - (7) Diazion
        - (8) Dipterex
        - (9) Piperonyl Butoxide
        - (10) N-Propyl Isome
        - (11) N-Octyl Dicycioheptane Dicar Boximide
        - (12) Methoxychlor
    - c. Identifying the characteristics of insect powders used for controlling insects
        - (1) Sodium Fluoride
        - (2) Powdered Pyrethrum
        - (3) Rotenone
        - (4) Borax and Boric acid
        - (5) Organic Thiocyanates
    - d. Identifying the characteristics of rodent baits used for controlling rodents.
        - (1) Anticoagulants
        - (2) Red squill
        - (3) Tracking powders and sticky boards
2. Controlling insects and rodents
    - a. Using sprays to control insects
        - (1) Determining where to spray depending on possible location of insects
        - (2) Using safety practices in applying sprays
        - (3) Selecting, measuring and mixing chemicals according to maufacturer's directions
    - b. Using baits to control insects and rodents
        - (1) Determining where to place bait
        - (2) Selecting and measuring dry bait and filling containers
        - (3) Selecting, measuring and mixing liquid baits and filling containers

- (4) Hanging bait in appropriate areas
- (5) Checking condition of bait to determine effect of control
- (6) Re-filling bait containers
- (7) Using safety practices in applying bait

c. Using fumigants to control insects and rodents

- (1) Selecting fumigants
- (2) Adjusting applicator
- (3) Using safety practices in the application of fumigants
- (4) Closing windows, doors and vents in preventing air from entering and the release of fumigants
- (5) Applying fumigants according to manufacturer's directions and plant demands
- (6) Checking fumigation room to determine the effects of plant fumigation
- (7) Ventilating the rooms after fumigation

Examples of Supporting References:

Supporting references were mentioned under Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor and students may visit an agricultural chemical supply store and ask the manager to explain in detail factors which should be considered in selecting chemicals for controlling insects and rodents. The store manager may be asked also to discuss the importance of using safety practices in the application of insecticides and rodenticides.

2. Have the students measure and mix insecticides according to manufacturer's directions.

3. Have students calibrate a manual chemical applicator according to specifications recommended by the instructor.

Examples of Evaluation Techniques:

1. Have students list areas where insects are usually located and explain the conditions which cause them to multiply in wastewater treatment systems.

2. Have students measure and mix insecticides according to manufacturer's directions.

3. Have students apply insecticides according to manufacturer's directions and the directions of the instructor. The instructor should evaluate the student on his or her ability to adjust the applicator and application techniques.

Instructional Resources:

1. Access to a building where insects and rodents are usually located
2. Various types of insecticides and rodenticides
3. Insecticides and rodenticide applicators
4. Respirators
5. Gas Mask
6. Protective clothing, rubber gloves, rubber boots

MODULE OF INSTRUCTION

CODE--01.99

SURVEYING LAND

Module Concept: The determination of grades and slopes and the surveying of drainage areas are important tasks in wastewater treatment systems and other operations due to the fact that in many cases water must be moved by gravity flow and/or drained from various places.

The purpose of this module is to describe for the instructor areas which should be taught relative to surveying so that the student will be able to determine grade levels and perform elementary surveying tasks while working in a wastewater treatment system or other types of operations.

Prerequisites: The module on Using Applied Mathematics in Solving Problems in Wastewater Treatment Systems is necessary before teaching this module. Courses in general mathematics would also be useful.

Module Goal: When this module of instruction is completed, the student will be able to determine grade levels and perform elementary surveying tasks.

Student Performance Objective 1: Given an area to be surveyed and access to various types of surveying equipment, the student will select the most appropriate type of survey to be used in surveying the area and give verbal or written reasons for selecting a specific type so that the area can be accurately surveyed without loss of time and labor and the reasons for selecting a specific type meets the approval of the instructor.

Instructional Areas:

1. Identifying the types and uses of legal surveys
    - a. Metes and bounds system
    - b. Rectangular survey system
2. Identifying the types and uses of conservation surveys
    - a. Differential leveling
    - b. Profile leveling
    - c. Topographic surveying

Examples of Supporting References:

1. Conservation Aide IV - Surveying. Prepared through the Agricultural Education Service, State Department of Education by the Department of Agricultural Education. The Ohio State University. Columbus, Ohio. 1972.
2. Schwab, Glenn O., Frevert, Richard K., Barnes, Kenneth K. and Edminster, Talcott W. Elementary Soil and Water Engineering. N.Y., N.Y: John Wiley and Sons, Inc. 1965.

Examples of Student Learning Activities:

1. The instructor and students may visit the local Soil Conservation District Office, and have personnel explain and demonstrate the use of the appropriate equipment in conducting the types of surveys that they usually perform.
2. Given a county platbook, the instructor may ask students to give the legal description of a given farm on the platemap.
3. Given access to an open field, the instructor may ask three students to measure the length and width of the field in rods.

Examples of Evaluation Techniques:

1. Given a surveying chain, the student should be able to measure the length and width of a field in rods within 95% accuracy.
2. Given a topographic map, the student should be able to use the map to explain the drainage requirement of a particular area to the satisfaction of the instructor.

Instructional Resources:

1. County Platemaps
2. Access to Soil and Water Conservation Office
3. Topographic maps
4. Examples of the types of surveys
5. Surveying chain

Student Performance Objective 2:

Given access to common types of surveying equipment, the student will identify and explain the types, their component parts and their functions according to the operator's manual.

Instructional Areas:

1. Identifying the common types of levels and their uses

    a. Transist level
    b. Contractor's level
    c. Builder's level
    d. Farm level
    e. Convertible level
    f. Dumpy level
    g. Hand level

2. Identifying the parts and functions of a level

    a. Foot plate
    b. Leveling screws
    c. Spirit level
    d. Eyepiece
    e. Cross hair ring
    f. Focusing screw
    g. Telescope
    h. Sunshade

3. Identifying equipment used in chaining and their uses

    a. Tapes
    b. Chaining pins
    c. Range poles
    d. Plumb bobs
    e. Locke level
    f. Clinometer
    g. Spring balance
    h. Thermometer

4. Identifying types of target rods and their uses

    a. Target rod
    b. Stadia rod

Examples of Supporting References:

Supporting references were discussed in Student Peformance Objective 1.

Examples of Student Learning Activities:

1. Given a farm level, the instructor may ask several students to point out the leveling screws and demonstrate their uses.
2. Given a box of chaining equipment, the instructor may ask three students to identify a plumb bob and demonstrate its' use.
3. Given a target rod, the instructor may ask two students to demonstrate the use of the rod.

Examples of Evaluation Techniques:

1. Given three types of levels commonly used, the student will be able to identify at least two of them and demonstrate their uses to the satisfaction of the instructor.
2. Given a level with a focusing screw, the student will be able to focus the instrument on a target rod in such a way that the markings on the rod are clearly readable.
3. Given a tape, the student will be able to measure a distance of 1000 feet accurately.

Instructional Resources:

1. Access to the following levels:
    a. Transist level
    b. Contractor's level
    c. Builder's level
    d. Farm level
    e. Dumpy level
2. Access to the following chaining equipment:
    a. Tapes
    b. Chaining pins
    c. Range poles
    d. Plumb bobs
    e. Locke level
    f. Clinometer
    g. Spring balance
    h. Thermometer
3. Access to target and stadia rods

Student Performance Objective 3:

Given access to surveying equipment, the student will transport, carry, set-up, and maintain the equipment according to the operator's manual.

Instructional Areas:

1. Caring for and protecting the level
    - a. Transporting the level in a vehicle
    - b. Carrying the level to a work site
    - c. Setting up the level
    - d. Cleaning and oiling the level
    - e. Making minor adjustments on the level
    - f. Storing the level after use
2. Caring for the chaining equipment
    - a. Transporting the equipment in a vehicle
    - b. Carrying the equipment to a work site
    - c. Using the equipment
    - d. Cleaning the equipment
    - e. Repairing the equipment
    - f. Storing the chaining equipment
3. Caring for the target rods
    - a. Transporting the rods in a vehicle
    - b. Carrying the rods
    - c. Setting up the rods
    - d. Cleaning the rods
    - e. Repairing the rods

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a level in its' case and located in a vehicle during a field trip, the instructor may ask a student to go to the vehicle and carry the level to the place of surveying.

2. After measuring with a tape in an area of mud, the instructor may ask three students to clean the tape.

3. While teaching on the land laboratory, the instructor may ask a student to demonstrate how to hold a target rod.

Examples of Evaluation Techniques:

1. Given a level, the student should be able to set it up and make adjustments for surveying to the satisfaction of the instructor.

2. A group of three students should be able to serve as tapers and place a chaining pin at each end of a chain while out in the land laboratory to the satisfaction of the instructor.

3. After completing a survey, the student should be able to carry the target rod to a vehicle without damage to the rod.

Instructional Resources:

1. A level
2. Chaining equipment
3. Target rod
4. Cleaning solutions and cloths
5. Vehicle to transport surveying equipment
6. Land laboratory for surveying

Student Performance Objective 4:

Given access to appropriate surveying equipment and a specified area to be surveyed, the student will perform the following surveying techniques and record field notes so well that the area is accurately surveyed and the field notes are accurate and written legibly

- a. Basic surveying operations
- b. Differential leveling
- c. Profile leveling
- d. Topographic leveling
- e. Hand leveling

Instructional Areas:

1. Performing basic surveying operations

    - a. Establishing benchmarks
    - b. Taking a backsight
    - c. Taking a foresight
    - d. Calculating the height of the instrument
    - e. Establishing a turning point
    - f. Using surveyor's hand signals

2. Performing a differential leveling task

    - a. Identifying the purposes or uses of differential leveling

- b. Setting up and leveling the level
- c. Reading the rod
- d. Recording the field notes
- e. Running a bench level circuit

    - (1) Selecting a bench mark
    - (2) Taking a backsight
    - (3) Calculating the height of the instrument
    - (4) Selecting a turning point
    - (5) Taking a foresight
    - (6) Closing the bench level circuit
    - (7) Calculating the percent error

3. Performing a profile leveling task

    - a. Identifying the purposes or uses of profile leveling
    - b. Taking the backsight reading from the bench-mark
    - c. Taking foresights
    - d. Establishing turning points
    - e. Recording field notes
    - f. Plotting the profile from field notes
    - g. Plotting physical changes planned for the areas measured

4. Performing a topographic survey

    - a. Identifying the purposes or uses of topographic surveys
    - b. Using the transit and stadia method

        - (1) Leveling the plates
        - (2) Setting the compass
        - (3) Taking the backsight and rod reading
        - (4) Using stadia hairs to determine distance
        - (5) Reading the compass and vernier
        - (6) Recording field notes
        - (7) Drawing the layout using the protractor rule

    - c. Using the grid method

        - (1) Determining when to use the grid method
        - (2) Establishing grid locations
        - (3) Establishing grid lines
        - (4) Recording field notes
        - (5) Preparing the map

d. Using the planetable and alidade method

  (1) Determining when to use the planetable method
  (2) Locating the instrument
  (3) Setting up the instrument
  (4) Plotting point on the drawing board

5. Using the hand level

  a. Determining eye height
  b. Determining contour lines
  c. Determining percent of slope

Examples of Supporting References:

In addition to supporting references discussed in Student Performance Objective 1, the following may also be helpful:

Engineering Field Manual for Conservation Practices. Washington, D.C. U.S. Department of Agriculture, Soil Conservation Service. 1969.

Examples of Student Learning Activities:

1. The instructor may ask two students to separate themselves by 50 yeards in a field and have one student give the other student the hand signal for extending the rod.

2. While using a level and a rod, the instructor may ask two students to demonstrate how to take a backsight.

3. Given a soil conservation service field notebook, the instructor and students may visit a soil conservation crew on a survey and the students may record their own field notes as the survey moves along.

4. Given a compass, the instructor may ask a student to use the compass to find the direction of North North West.

5. Given a hand level, the instructor may have two students determine the percent of the slope on a given hill without the use of a rod.

Examples of Evaluation Techniques:

1. Given a hypothetical bench level circuit, the student should be able to complete the field notebook accurately.

2. Given a hand level, two students should be able to determine the percent slope of a hill with the level to within ±2 percent of the actual slope.

Instructional Resources:

1. Level
2. Rod
3. Soil conservation service field notebooks
4. Access to a soil conservation survey crew
5. Compass
6. Hand level
7. Land laboratory for surveying

MODULE OF INSTRUCTION

CODE--01.99

USING APPLIED HYDRAULICS IN SOLVING PROBLEMS IN WASTEWATER TREATMENT SYSTEMS

Module Concept: In order to prevent problems in wastewater treatment systems which are associated with the flow of water, plant personnel must be knowledgeable of the flow of water, the use of pumps and the effect of pressure exerted by water.

The purpose of this module is to depict for the instructor areas which should be taught relative to using applied hydraulics so that the student will be able to effectively use this information while working in wastewater treatment systems.

Prerequisites: A module on Using Applied Mathematics in Solving Problems in Wastewater Treatment Systems is necessary before studying this module. Courses in general mathematics and physics would be useful.

Module Goal: When this module of instruction is completed, the student will be able to apply hydraulic principles in solving problems in wastewater treatment systems which are related to the flow of water.

Student Performance Objective 1: Given a specified number of basic terms common in the field of hydraulics, the student will explain verbally or in writing 95% of the terms according to appropriate references.

Instructional Areas:

1. Defining basic hydraulic terms used in wastewater treatment systems

    a. Fluid
    b. Weight
    c. Specific gravity
    d. Elevation
    e. Head
    f. Areas
    g. Volume
    h. Units of flow
    i. Slope
    j. Hydraulic radius

2. Determining relationships of basic hydraulic terms such as:

    a. Weight-specific gravity
    b. Elevation-head
    c. Volume-weight

Examples of Supporting References:

1. A Basic Course in Applied Hydraulics for Water and Wastewater Plant Operators. Sanitary and Resources Engineering. University of Michigan. 1973.

2. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970.

Examples of Student Learning Activities:

1. The instructor may have several materials in one inch cubes (such as copper, wood and plastic) and ask several students to weigh at least 3 cubes and noting the differences in weight, explain the hydraulic terms involved, such as specific gravity.

2. The instructor may secure several plastic tubes about 3 feet long, and may ask several students to pour water in the tube to make it about half full when bent in a u-shape. The students may then be asked to raise and lower the ends of the tubing without letting any water out and note the changes in water level in the two sides and explain how the term "head" applies to the demonstration.

3. The instructor and students may visit an operational pumping station and have the students observe the flow through a flow measuring device and explain the units of flow used to measure that particular fluid.

4. The instructor may have several students fill a bucket with water and weight it, then using a gallon jar measure the quantity of water in the pail and express the two findings in weight-volume relationships.

Examples of Evaluation Techniques:

1. Students should use a measuring tape to measure the circumference of a pipe that cannot be taken down, and compute the inside diameter with 95% accuracy.

2. The student should be able to list and explain the relationships of at least 6 basic hydraulic terms used in wastewater treatment systems.

3. Given a bucket of water, the student should be able to weigh the water in pounds and measure it in pints and explain the weight-volume relationship accurately.

Instructional Resources:

1. Three foot pieces of plastic tubing about ½ inch in diameter
2. Measuring tape
3. Bucket
4. Gallon measuring jar
5. Several materials in one inch cubes or same size shapes
6. Scale for weighing in pounds and ounces
7. Access to an operational pump with a flow measuring device

Student Performance Objective 2:

Given a specified number of mathematical problems to be solved, the student will explain and use the principles of pressure to accurately solve 95% of the mathematical problems given which are common to wastewater treatment systems.

Instructional Areas:

1. Defining terms used in working with pressure

    a. Total pressure
    b. Unit pressure
    c. Pascal's principle
    d. Absolute pressure
    e. Gauge pressure
    f. Variable pressure

2. Converting of unit to total pressure

    a. Using the appropriate equation in converting
    b. Calculating an average pressure
    c. Using gauges to determine pressure

3. Using pressure principles in solving mathematical problems
   a. Calculating total pressure by considering:
      (1) Volume
      (2) Weight
   b. Calculating unit pressure by considering:
      (1) Weight
      (2) Height or depth
   c. Using Pascal's principle to determine water pressure by considering:
      (1) Height or depth of water
      (2) Weight or water per unit
   d. Reading gauge pressures
   e. Calculating average pressure by considering:
      (1) Height
      (2) Pressure at surface and bottom

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may give mathematical problems for students to solve similar to the ones listed below:

   a. A problem in calculating unit pressure
   Given a guage on a tank which indicates the pressure is 19.2 P.S.I, how high in feet is the water level above the gauge?

   The formula for determining pressure is:
   $p=wh$ where p = unit pressure in lbs. per sq. ft.
   w = weight of a cubic foot of water
   h = depth of water in feet above the point

   Note: Water is known to be 62.4 pounds per cubic foot

   Each cubic foot of water is (12 x 12)= 144 cubic inches of water

Solution:

$P = 19.2 \times 144 = 2764.8$ lb/sq feet

$\frac{2764.8}{62.4} = 44.3$ feet high

b. A problem in calculating total pressure
Given a cork with an area of .3 square inches in a tank with a gauge reading of 44.3 feet of water, what force would be required to blow the cork out?

The formula for determining the total pressure is:

$P = pA$ where P = Total pressure
p = Unit pressure
A = Area in appropriate units

Solution:

$62.4 \times 44.3 = 2764.3$ lbs/foot

$\frac{2764.3}{144} = 19.1$ P.S.I.

$\frac{19.1}{.3} = 63.6$ lbs. on the cork

2. The instructor and students may visit a wastewater treatment system and the students may read several gauges and identify the mathematical units in which the gauge is measuring.

Examples of Evaluation Techniques:

1. Given problems similar to the ones in the student learning activities, the student should be able to calculate 95% of the problems accurately.
2. The student should be able to read a gauge and record the gauge reading to the satisfaction of the instructor.

Instructional Resources:

1. Access to a wastewater treatment system
2. Actual data from a wastewater treatment system which the student has collected and would be useful in making calculations

Student Performance Objective 3:

Given accurate information and mathematical problems related to pipes and other conduits in wastewater treatment systems, the student will accurately solve 95% of the mathematical problems given.

Instructional Areas:

1. Defining terms used in calculating flow

    a. Pipe flow
    b. Open flow
    c. Equation of continuity
    d. Pressure head
    e. Elevation head
    f. Velocity head
    g. The Bernoulli equation

2. Using flow principles in solving mathematical problems

    a. Calculating pipe rate of flow by considering:

        (1) Cross-sectional area
        (2) Velocity

    b. Calculating open rate of flow by considering:

        (1) Velocity
        (2) Area

    c. Calculating flow in different sizes of pipes using the equation of continuity by considering:

        (1) Velocity
        (2) Area

    d. Calculating pressure head by considering:

        (1) Unit pressure
        (2) Weight of water in lbs per cubic feet

    e. Calculating elevation head by considering:

        (1) Velocity
        (2) Acceleration due to gravity

    g. Using the Bernoulli equation to calculate mathematical problems of fluid flow by considering:

        (1) Total head
        (2) Head loss
        (3) Velocity

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given the opportunity to visit a sprinkler irrigation system, the instructor should provide students with information regarding the size of the sprinkler heads under normal operating conditions with the use of service manuals.

2. The instructor may ask three students to run the same amount of tap water through pipes of ½ inch diameter and 2 inch diameter and explain the reasons for changes in velocity of running water.

3. The instructor may have two students set up a siphoning demonstration and show how the height of the siphon effects the amount of flow and explain the relationship of the demonstration to pressure head.

Examples of Evaluation Techniques:

1. The student should be able to explain the meaning of at least 5 terms used in calculating flow problems.

2. Given needed information, the student should be able to calculate the flow of water through a pipe with 95% accuracy.

Instructional Resources:

1. Access to a sprinkler system and service manual
2. A tube for siphoning and container from which to siphon

Student Performance Objective 4:

Given mathematical problems related to the flow in open channels in wastewater treatment systems, the student will accurately solve 95% of the problems given.

Instructional Areas:

1. Calculating mathematical problems in open channels by considering:

    a. Cross-sectional area of flow

   - b. The wetted perimeter
   - c. The hydraulic radius

2. Calculating mathematical problems in circular sections which are partially full by considering:
   - a. Area of flow
   - b. Hydraulic radius
   - c. Velocity of flow
   - d. Quantity of flow

3. Calculating flow in open channels with the use of nomographs
   - a. Circular channels
   - b. Other than circular channels

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may obtain several nomographs and ask students to demonstrate the use of nomographs and explain why one may be used.

2. The instructor and students may visit a wastewater treatment system and have the students identify and explain the reasons for different types of channels.

3. The instructor may have three students make wooden models of at least two shapes of channels and explain the purpose for different shapes.

4. The instructor may have several students demonstrate the use of a model channel and explain how the shape affects the flow of water.

Examples of Evaluation Techniques:

1. The student should be able to identify and explain at least three different types of channels.

2. The student should be able to use a nomograph to compute the size of circular drain to the satisfaction of the instructor.

Instructional Resources:

1. Wood, hammer, saw and nails
2. Nomographs
3. Access to a wastewater treatment system

Student Performance Objective 5:

Given accurate information and mathematical problems related to pumps, students will accurately calculate 95% of the problems given.

Instructional Areas:

1. Defining terms related to mathematical problems in pumps and pumping
    a. Work
    b. Power
    c. Horsepower
    d. Water horsepower
    e. Brake horsepower
    f. Motor horsepower
    g. Static head
    h. Total head
    i. Friction
    j. Efficiency
    k. Capacity
    l. Kilowatts
2. Solving mathematical problems in pumps and pumping
    a. Calculating work by considering:
        (1) Weight in pounds
        (2) Height in feet
    b. Calculating power by considering:
        (1) Work in foot-pounds
        (2) Time in seconds
    c. Calculating horsepower by considering:
        (1) Power in foot-pounds/minute
        (2) Horsepower as 33,000 ft-lbs.
    d. Calculating water horsepower by considering:
        (1) Gallons of flow
        (2) Lift in feet
        (3) Weight of the water in pounds
    e. Calculating brake horsepower by considering:

- (1) Efficiency of the pump
- (2) Flow in gallons per minute
- (3) Height in feet

f. Calculating motor horsepower by considering:

- (1) Efficiency of motor
- (2) Flow in gallons per minute
- (3) Height in feet

g. Calculating static head by considering:

- (1) Suction lift
- (2) Discharge head

h. Calculating total head by considering:

- (1) Static head
- (2) Friction losses

i. Calculating friction losses by considering:

- (1) Static head
- (2) 10% of static head

j. Calculating efficiency of a pump by considering:

- (1) Gallons per minute
- (2) Height in feet
- (3) Brake horsepower

k. Calculating capacity of a pump by considering:

- (1) Volume in gallons
- (2) Time in minutes

l. Calculating Kilowatts use of a pump by considering:

- (1) Horsepower
- (2) Kilowatts/horsepower
- (3) Time operated

Examples of Supporting References:

In addition to supporting references discussed in Student Performance Objective 1, the references listed below may be useful:

1. Manual of Instruction for Sewage Treatment Plant Operators. Health Education Service. P.O. Box 7283 Albany, New York. 12224. Chapter 15.

Examples of Student Learning Activities:

1. The instructor and students may visit a repair shop that has a dynamometer for measuring the horsepower of a motor.

2. The instructor may ask several students to read the electric meters in their homes at the beginning and end of the month and calculate the number of kilowatts used in their homes for the month.

3. The instructor may ask several students to place a jar of water upside down in a basin of water and explain the effects of pressure in holding the water in the jar above the level of the basin water.

4. Given a centrifugal pump, the instructor may ask several students to operate the pump and explain how the height of water to be pumped affects the capacity of the pump.

Examples of Evaluation Techniques:

1. Students should be able to weigh himself/herself, measure the height of a chair and while stepping up on the chair, explain to the class how much actual work was exerted in stepping up on the chair in foot-pounds.

2. Students should then be able to calculate the amount of horsepower he/she exerted by stepping up on the chair

3. Given a point where water must be lifted and a pump designed to pump only against the head (e.g. to the point where it must be lifted), the student should be able to explain the reasons the water is not being lifted to the necessary height by the pump. Some reasons should include:

   Friction in the pipe and pump efficiency.

4. Given the characteristics of a pump (e.g. speed, head, power, impeller design) the student should be able to draw a graph illustrating efficiency vs. capacity and explain their relationship to the satisfaction of the instructor.

Instructional Resources:

1. A chair
2. Scale for weighing a person
3. Scale for measuring
4. Graphs of efficiency-capacity and brake horsepower-capacity relationships
5. Access to a dynamometer
6. Access to electrical meters
7. Jar and basin
8. Operational centrifugal pump
9. Samples of pipe
10. Charts on friction loss in various pipes

A SET OF MODULES FOR PREPARING
WASTEWATER TREATMENT LABORATORY TECHNICIANS
(SEE LIST OF STUDENT PERFORMANCE OBJECTIVES FOR
THE LOCATION(S) OF MODULES NOT FOUND HERE)

USING FIRST AID TECHNIQUES IN A WASTEWATER TREATMENT SYSTEM

CODE--01.99

Module Concept:

It is important that all workers in a wastewater treatment system think safety. Most accidents may be prevented by using good common sense. However, unfortunately, accidents do occur. When they occur, the wastewater treatment personnel should know what action to take to reduce suffering and the possibility of further injury.

The purpose of this module is to depict for the instructor areas which should be taught relative to first aid techniques to use on injuries that may occur in the wastewater treatment system.

Prerequisites:

Admission to the Environmental Technology Program is sufficient evidence of qualification for entry into this course. Additional courses in Red Cross First Aid training would be helpful.

Module Goal:

At the completion of this module, the student will be able to use first aid techniques to treat for injuries and accidents most commonly occuring in wastewater treatment systems.

Student Performance Objective 1:

Given simulated accidents which commonly occur in wastewater treatment systems, the student should be able to demonstrate the proper use of first aid techniques in handling the following problems:

a. Body damages due to chemical spills
b. Boby damage as a result of burns
c. Bleeding of the body, caused by cuts
d. Electrical shocks

according to instructions in given first aid manual.

Instructional Areas:

1. Treating for chemical spills on the body
    a. For treatment of chlorine spills the instructor may refer to the module entitled Disinfecting and Chlorinating Effluent.
    b. Acid and alkali burns
        (1) Washing immediately with large quantities of water

(2) Neutralizing with appropriate chemical agent: Dilute sodium bicarbonate solution for acid burns, vinegar or dilute acetic acid for alkali burns.

2. Treating for burns of the body

a. If the skin is not borken, use cold running water until pain is gone

b. If blisters appear, cover blisters with dry, sterile gauze, keeping in place with a bandage.

c. If there is charred flesh, wrap clean cloth around the burn, treat for shock and get the victim to a doctor.

3. Treating bleeding of the body caused by cuts

a. Small cuts and scratches

(1) Washing the cuts or scratch with soap and water
(2) Applying an adhesive bandage

b. Larger cuts

(1) Washing cut with soap and water
(2) Applying a sterile dressing large enough to cover the entire wound
(3) Holding dressing in place with adhesive tape or a cloth bandage

c. Severe bleeding

(1) Pressing down hard on the wound
(2) Quickly using free hand to get a cloth pad on the wound
(3) Tieing the pad in place snugly
(4) Getting victim to medical help

4. Treating for electrical shocks

a. Separating the victim from the current source

(1) Cutting off source of electricity
(2) Removing victim by pulling free with insulating material

b. Re-establishing vital functions

(1) If no pulse, cardiac massage
(2) If no spontaneous respiration, mouth-to-mouth resuscitation

c. Getting medical attention

5. Treating for something in the eye
    a. Blinking and letting the tears flow
    b. Pulling out upper lid and down
    c. Placing thumb just below lower lid and moving it down gently
    d. If above procedures fail, hold a bandage over the eye and seek medical attention

Examples of Supporting References:

1. The Merck Manual of Diagnosis and Therapy. Rahway, N.J.: Merck Sharp and Dohme Research Laboratories. current edition.

2. Scout Manual. North Brunswick, New Jersey: Boy Scouts of America. current edition

3. First Aid. Boy Scout Merit Badge Pamphlet. North Brunswick, N.J.: Boy Scouts of America. current edition.

Examples of Student Learning Activities:

1. Given a simulated situation in which one student is lying across live electrical wires, the instructor may ask two students to demonstrate how they would free the victim from the live wires.

2. Given a simulated burn, the instructor may have two students treat and cover the burn as a third-degree burn.

Examples of Evaluation Techniques:

1. Given a simulated chemical spill on the arm, the student should be able to use the correct procedures in treating the chemical spill to the instructor's satisfaction.

2. Given a simulated larger cut, the student should be able to treat the wound through the first two steps appropriate for treating larger cuts.

Instructional Resources:

1. First aid books
2. Access to running water
3. Supply of sterile gauze
4. Supply of bandage material
5. Supply of adhesive tape
6. Soap
7. Samples of insulating material commonly found in wastewater treatment systems
8. First aid kit

Student Performance Objective 2:

Given simulated accidents which commonly occur in wastewater treatment systems, the student should be able to demonstrate the proper use of first aid techniques in handling the following problems:

- a. Stopped breathing
- b. Internal poisoning
- c. Unconsciousness
- d. Bone fractures

according to instructions in given first aid manual.

Instructional Areas:

1. Restoring breathing
    - a. Performing mouth-to-mouth resuscitation
        - (1) Clearing victim's mouth of anything that might stop breathing
        - (2) Tilting head back as far as possible
        - (3) Pinching victim's nose with thumb and forefinger, place mouth over victim's mouth and blow 12 times a minute for adults and 20 times a minute for children (Chest should rise)
        - (4) Removing mouth from victim's, let the victim breathe out
        - (5) If air isn't getting into lungs, slap victim's back to clear the throat.
2. Restoring breathing and circulation
    - a. Performing mouth-to-mouth resuscitation
    - b. Performing external cardiac compression with a second person administering mouth-to-mouth resuscitation
        - (1) Placing heel of one hand over lower half of sternum then other hand on top of first
        - (2) Rocking forward with arms straight, using upper part of your body
        - (3) Repeat process once each second

3. Treating for internal poisoning
    - a. Getting the victim to drink a glass of water if conscious
    - b. Searching for the bottle or can and follow directions on the label
    - c. Phoning poison control center
    - d. Seeking medical attention

4. Treating for inhaled poisons
    - a. Removing patient from uncontaminated atmosphere
    - b. Keeping victim lying down and warm
    - c. Maintaining clear airway
    - d. Using artificial respiration only if necessary
    - e. Also see module Disinfecting and Chlorinating Effluent under Wastewater Treatment Operator

5. Treating an unconscious person
    - a. Simple fainting
        - (1) Lying victim flat with head low
        - (2) Loosen clothing around victim's neck
        - (3) Lying flat for ten minutes after becoming conscious
    - b. Unknown unconsciousness
        - (1) Checking person to see if breathing
        - (2) If not breathing, use artificial respiration
        - (3) If breathing, get victim flat
        - (4) Checking person for a neck, wrist or ankle tag for special instructions
        - (5) Don't expose to cold air
        - (6) Seek medical attention, bringing expert to the victim when possible

6. Treating bone fractures
    - a. Lying victim where he or she is with little motion
    - b. Moving victim only in extreme emergency
    - c. Making victim comfortable with something over and under him
    - d. Calling a doctor or ambulance

e. Treating for shock

   (1) Raising feet where possible
   (2) Letting person sip water if conscious

f. In extreme emergency

   (1) Splinting patient where he is before moving

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a model on which to practice mouth-to-mouth resuscitation, the instructor may ask several students to hold the nose of the model and blow enough to cause the chest of the model to rise.

2. Given a leg splint, the instructor may ask three students to demonstrate the use of the splint with one student at a time acting as the patient.

Examples of Evaluation Techniques:

1. Given a simulated fracture, the student should be able to identify at least three signs of a broken bone.

2. Given a simulated case of internal poisoning, with the bottle from which the poison came, the student should be able to determine the steps to take in treating the victim according to the label on the container.

Instructional Resources:

1. First aid kit commonly found in wastewater systems
2. First aid equipment for treatment of chlorine and other gas inhalation accidents
3. Samples of various splints
4. Blankets
5. Model on which to practice mouth-to-mouth resuscitation
6. Information on local poison control center

USING SAFETY PRACTICES IN THE WASTEWATER TREATMENT LABORATORY

CODE--01.99

Module Concept: Accident prevention is a result of thinking ahead and understanding the hazards and dangers one may face while working in a wastewater treatment laboratory.

The purpose of this module is to depict for the instructor areas which should be taught relative to safety and hygiene in the wastewater treatment laboratory to enable the student to work safely and be aware of the potential dangers at all times.

Prerequisites: Admission to the Environmental Technology Program is sufficient evidence of qualification for entry into the course.

Module Goal: At the completion of this module, the student will be aware of and alert to the hazardous materials and conditions that exist in a wastewater treatment laboratory.

Student Performance Objective 1: While touring or working in a testing laboratory, the student will:

- a. Verbally identify safety equipment by their common names and explain their uses
- b. Give verbal reasons why the equipment is located in various areas in the test laboratory

according to the manufacturer's identification of equipment.

Instructional Areas:

1. Identifying safety equipment and determining their uses:
    - a. Rubber gloves and boots
    - b. Warning signs and antidotes
    - c. Fire extinguishers for all types of fires
    - d. Breathing apparatus
    - e. Inhalators
    - f. Portable blowers
    - g. First aid kits
    - h. Vented hood
    - i. Face mask or safety goggles
    - j. Adequate ventilation
    - k. Protective gloves and tongs
    - l. Protective caps on oxygen cylinders

2. Locating safety equipment

Examples of Supporting References:

a. Determining reasons for location

1. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health.
2. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento, California. 1970.

Examples of Student Learning Activities:

1. Given a rechargable fire extinguisher and a fire in a safe location, the instructor may ask several students to demonstrate the operation of the fire extinguisher.

2. Given access to a wastewater treatment laboratory containing safety goggles, the instructor may ask several students to demonstrate the use of the goggles and explain under what laboratory conditions they should be worn.

Examples of Evalution Techniques:

1. Given access to a wastewater treatment laboratory, the student should point out the location of at least ten different articles of safety equipment.

2. Given a fire extinguisher commonly located in a wastewater treatment laboratory, the student should be able to read the instructions and correctly identify the types of fires for which the given fire extinguisher was designated to put out.

Instructional Resources:

1. Access to a wastewater treatment laboratory
2. Samples of each item of safety equipment found in the laboratory

Student Performance Objective 2:

While touring or working in a testing laboratory, the student will identify and verbally explain safety hazards of the equipment and facilities according to commonly listed safety hazards as described in wastewater laboratory literature.

Instructional Areas:

1. Identifying and explaining the hazards of infectious materials:
    - a. Wastewater
    - b. Sludge
    - c. Using innoculations for protection against infectious materials
2. Identifying and explaining the hazards of corrosive chemicals
    - a. Acids
        - (1) Adding acid to water
        - (2) Using glassware or polyethylene containers
        - (3) Diluting and neutralizing
    - b. Bases
        - (1) Using glassware or polyethylene containers
        - (2) Using a laboratory hood with fan
        - (3) Neutralizing bases with saturated boric acid
    - c. Other hazards
        - (1) Avoid inhaling chlorine gas
        - (2) Avoid body contact with corrosive metals such as ferric salts
        - (3) Avoid body contact with strong oxidants
3. Identifying and explaining the hazards of toxic materials
    - a. Solids
        - (1) Cyanide, chromium, cadmium and other heavy metals
    - b. Liquids
        - (1) Carbon tetrachloride, ammonium hydroxide, nitric acid, bromine, chlorine water, aniline dyes, formaldehyde, chloroform, and carbon disulfide.

c. Gases

(1) Hydrogen sulfide, chlorine, ammonia, nitric and hydrochloric acid

d. Avoid ingesting or inhaling above materials

4. Identifying and explaining the hazards of explosive or inflamable materials

a. Gases of acetylene and hydrogen
b. Liquids of carbon disulfide, benzene, ethyl ether, petroleum ether, acetone and gasoline
c. Storing according to fire regulations
d. Not using near open flame or heating elements
e. Using a face mask
f. Securing all containers

5. Identifying and explaining the hazards of broken equipment

a. Throwing away beakers, flasks, test tubes and other inexpensive glass equipment when chipped or broken
b. Salvaging expensive equipment where possible
c. Avoiding cuts from broken edges

6. Identifying and explaining the hazards of miscellaneous equipment and conditions

a. Using safety goggles wherever danger to eyes exist
b. Wearing gloves to make rubber to glass connections
c. Always checking labels before using chemicals
d. Avoiding toxic fumes
e. Avoiding smoking and eating when working with infectious materials
f. Using proper equipment when handling hot containers or heating materials

7. Observing personal hygiene

a. Thoroughly washing of hands
b. Receiving immunizations against tetanus, typhoid and polio
c. Changing clothes before going home
d. Wearing appropriate clothing
e. Protecting cuts and wounds from infection

(1) Band aids
(2) Rubber gloves or protective clothing

f. Do not pipette wastewater by mouth
g. Avoid putting hands to mouth while working in the laboratory

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a weak acid and water, the instructor may ask two students to demonstrate how to add the acid and water and explain the dangers of adding water to acid.

2. Given a chipped glass tube, the instructor may ask several students to flame polish the chip by placing the edge in a flame and allowing the edge to melt slightly.

Examples of Evaluation Techniques:

1. Given a beaker containing a corrosive base, the student should be able to select the appropriate acid and neutralize the base, in a safe manner.

2. Given a cylinder of hydrogen, the student should be able to correctly explain the fire regulations in storing a cylinder.

Instructional Resources:

1. Access to a wastewater treatment laboratory
2. Samples of bases and acids
3. Samples of neutralizing agents for bases and acids
4. Sample of glass tubing with chip
5. Bunsen burner
6. Access to laboratory safety equipment

Student Performance Objective 3:

Given the task of operating fire control equipment in a simulated exercise, the student will select and use the fire control equipment tc control the fire in the simulated exercise prepared by the instructor.

Instructional Areas:

1. Determining the ingredients for a fire

2. Determining the types of fires

    a. Class A
    b. Class B
    c. Class C

3. Selecting fire control equipment
    a. Water
    b. Carbon dioxide
    c. Dry chemical
    d. Others

4. Using fire control equipment

Examples of Supporting References:

1. *Handbook of Fire Protection*. National Fire Protection Association.

Examples of Student Learning Activities:

1. Given a simulated electrical fire in a wastewater treatment laboratory, the instructor may ask several students to select the equipment designed for use on electrical fires.

2. Given the safety hazards in a wastewater treatment laboratory, the instructor may invite the local fire department to speak to the students concerning fire protection in the laboratory.

Examples of Evaluation Techniques:

1. The student should be able to list three ingredients necessary for a fire.

2. Given a series of four slides showing typical fires that occur in a wastewater treatment laboratory, the student should be able to determine the type of fire extinguisher to be used on at least three of the fires.

Instructional Resources:

1. Access to wastewater treatment laboratory
2. Samples of fire extinguishers for each type of fire
3. Set of slides showing various types of fires in a wastewater treatment laboratory
4. Access to fire department personnel

Student Performance Objective 4:

Given a simulated accident in the wastewater treatment laboratory, the student will write-up the accident consistent with the actual occurance.

Instructional Areas:

1. Investigating the injury
    a. Visiting the scene of the accident
    b. Interviewing the injuried person
    c. Interviewing any witnesses
2. Writing an accident report accurately on appropriate forms
3. Using appropriate procedures in filing an accident report

Examples of Supporting References:

1. Safety in Wastewater Works. Water Pollution Control Federation. WPCF Manual 1. Washington, D.C. 1969

Examples of Student Learning Activities:

1. Given a simulated accident in a wastewater treatment laboratory, the instructor may divide the class into pairs of students and have one student in the pair interview the other regarding the details of the accident.
2. Given a simulated accident in a wastewater treatment laboratory, the instructor may ask two students to prepare a report on the importance of making out accurate accident reports.

Examples of Evaluation Techniques:

1. Given an accident report form and a simulated accident in the wastewater treatment laboratory, the student should be able to complete the form with 95% accuracy.

2. Given a simulated accident in a wastewater treatment laboratory, the student should be able to visit the accident scene and write down five significant facts concerning the accident

Instructional Areas:

1. Access to a wastewater treatment laboratory
2. Samples of accident report forms
3. List of legal requirements relating to writing and submitting accident reports

CODE--01.99

GROOMING ESSENTIALS AND THE USE OF HYGIENIC PRACTICES IN A WASTEWATER TREATMENT LABORATORY

Module Concept: Workers in wastewater treatment laboratories come into contact with sewage which exposes them to the hazards of water-borne diseases. Wastewater Treatment Systems are also funded by the public and therefore open to the public under certain conditions. Consequently, it is essential for the wastewater treatment laboratory technician to understand the essentials of good grooming and the use of hygienic practices in a laboratory. The purpose of this module is to depict for the instructor areas which should be taught relative to grooming and hygienic practices in a wastewater treatment laboratory.

Prerequisites: Admission to the Environmental Technology Program is sufficient evidence of qualification for entry into the course.

Module Goal: At the completion of this module, the student will be able to understand and practice grooming essentials and the use of hygienic practices in a wastewater treatment laboratory.

Student Performance Objective 1: While working in a wastewater treatment laboratory, the student will exhibit personal dress and grooming consistent with available information and based on local norms.

Instructional Areas:

1. Determining appropriate grooming

   a. Appearing neat and clean
   b. Hair appropriately cared for

2. Determining appropriate personal dress

   a. Appearing neat and clean
   b. Wearing laboratory clothing as required
   c. Changing from working clothing to street clothing before leaving work
   d. Wearing protective clothing, as required
      (1) Boots
      (2) Gloves
      (3) Waterproof clothing

Examples of Supporting References:

1. Kerri, Kenneth D., Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College, 1970.

Examples of Student Learning Activities:

1. Given the task of collecting a sample of wastewater from an aerator, the instructor may ask several students to select from a collection of clothing the appropriate protective clothing to wear while collecting the sample.

2. The instructor may ask several students to prepare a report for the class on the subject, "Who is responsible for appropriate dress in a wastewater treatment laboratory?"

Examples of Evaluation Techniques:

1. The student should be able to orally explain the importance of appropriate grooming in a wastewater treatment laboratory to the satisfaction of the instructor.

2. The student should be able to report to work dressed in an appropriate manner established by the instructor or employer.

Instructional Resources:

1. Access to a wastewater treatment laboratory
2. Samples of protective clothing commonly found in a wastewater treatment laboratory

Student Performance Obejctive 2:

While working in a wastewater treatment laboratory, the student should be able to use hygienic practices which meet or exceed laboratory standards stated in Operation of Wastewater Treatment Plants by Kenneth Kerri.

Instructional Areas:

1. Protecting against diseases
    a. Receiving immunizations
        (1) Tetanus
        (2) Typhoid
        (3) Polio
        (4) Smallpox
    b. Regular T.B. testing
    c. Protecting against diseases contacted through cuts and scratches
        (1) Band aids
        (2) Protective clothing
2. Protecting against ingesting or swallowing disease infected materials
    a. Thoroughly cleaning hands, face and body
        (1) Washing with soap and water
    b. Keeping hands away from mouth, eyes and ears
3. Using protective clothing
    a. Wearing gloves and/or boots wherever necessary
    b. Using face mask and goggles as required

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may ask two students to consult the local health department and report to the class concerning how often and where T.B. testing is done in the county.

2. Given a pair of goggles commonly worn by a wastewater treatment laboratory technician, the instructor may ask several students to demonstrate on themselves the wearing of the goggles.

Examples of Evaluation Techniques:

1. The student should be able to list at least five gastrointestinal diseases that can be transmitted by careless hygiene.

2. The student should be able to list three immunizations that every wastewater treatment system personnel should have.

Instructional Resources:

1. Access to a local health department
2. A first aid kit
3. Access to soap and water for hand washing
4. Samples of protective clothing commonly worn in a wastewater treatment laboratory
5. Charts of immunization schedules

WASHING AND STERILIZING LABORATORY EQUIPMENT

CODE--01.99

Module Concept: Clean, and in some cases, sterilized equipment is necessary to obtain correct laboratory test results. The purpose of this module is to depict for the instructor areas which should be taught relative to the selecting and using cleaning materials and sterilization equipment to enable the student to work in a wastewater treatment laboratory effectively cleaning and sterilizing equipment.

Prerequisites: Admission to the Environmental Technology Program is sufficient evidence of qualification for entry into the course.

Module Goal: At the completion of this module, the student will be able to select and use cleaning materials in washing laboratory equipment and will be able to use sterilization equipment in sterilizing laboratory equipment.

Student Performance Objective 1: Given the task of washing equipment commonly used in a wastewater treatment system laboratory, the student will select and use appropriate cleaning materials in washing given laboratory equipment without breaking the equipment and in such a way that no particles are visible.

Instructional Areas:

1. Selecting cleaning materials for washing equipment
    a. Identifying various cleaning agents
    b. Determining the requirements for given situations
2. Washing and rinsing laboratory equipment
    a. Selecting washing equipment
    b. Washing laboratory equipment
    c. Rinsing and drying laboratory equipment

Examples of
Supporting
References:

1. Burrows, William. Textbook of Microbiology. Philadelphia: W.B. Saunders Company. 1963.

Examples of
Student Learning
Activities:

1. Given a test tube brush and a test tube, the instructor may ask several students to demonstrate the use of the test tube brush in cleaning a test tube.

2. Given the need for a cleaning agent for given laboratory equipment, the instructor may ask several students to report orally to the class on the advantages, if any, of one given cleaning agent over another given cleaning agent.

Examples of
Evaluation
Techniques:

1. Given a sink full of laboratory dishes to wash, the student should be able to add the appropriate amount of given cleaning agent according to the directions on the container.

2. Given the task of washing a test tube, the student should be able to select the appropriate equipment to clean the test tube to the satisfaction of the instructor.

Instructional
Resources:

1. Laboratory equipment to be washed
2. Samples of various cleaning agents
3. Cleaning materials to include brushes, test tube brushes of various sizes and cloths
4. Access to a sink for washing dishes

Student
Performance
Objective 2:

Given the responsibility of sterilizing equipment commonly used in a wastewater treatment system laboratory, the student should be able to select and use appropriate sterilizing equipment to sterilize given laboratory equipment according to directions specified by the manufacturer of the sterilizer.

Instructional
Areas:

1. Washing equipment

2. Preparing equipment for the sterilizing unit

    a. Plugging flasks and tubes with cotton
    b. Wrapping or placing in cans petri dishes and pipettes

3. Placing equipment in sterilizing unit

   a. Packing - not too tight

4. Operating sterilization equipment

   a. Autoclaving

      (1) Determining time at 120 degrees C
      (2) Turning on equipment
      (3) Turning off after time is up
      (4) Letting pressure off slowly
      (5) Removing equipment after cooling is completed

   b. Other sterilization equipment

      (1) Determining length of time
      (2) Turning on equipment
      (3) Turning off equipment
      (4) Removing equipment from sterilization unit

Examples of Supporting References:

1. Burrows, William. Textbook of Microbiology. Philadelphia: W.B. Saunders Company. 1963

Examples of Student Learning Activities:

1. Given a simulated activity of packing laboratory equipment in an autoclave, the instructor may ask two students to explain why the equipment should not be packed tightly.

2. Given an autoclave commonly used in a wastewater treatment laboratory, the instructor may ask several students to demonstrate the method of closing the autoclave securely.

Examples of Evaluation Techniques:

1. Given a petri dish to be sterilized and material for wrapping the dish, the student should be able to wrap the dish in such a way that it is ready to place in an autoclave.

2. Given an autoclave to operate, the student should be able to demonstrate the correct method of letting off the pressure by following the manufacturer's directions.

Instructional Areas:

1. Access to laboratory sterilization equipment
2. Laboratory equipment to be sterilized
3. Clean cotton

USING THE MICROSCOPE

CODE--01.99

Module Concept:

The microscope is an important instrument in the Wastewater Treatment Laboratory for the purpose of identifying very small organisms in water and wastewater which are not large enough to see with the naked eye. The use and care of the microscope is important for wastewater treatment personnel because it is an expensive instrument that requires some instruction to use.

The purpose of this module is to depict for the instructor areas which should be taught relative to using the microscope under laboratory conditions to enable the student to effectively and correctly use the microscope in wastewater treatment microbiology.

Prerequisites:

Admission in the Environmental Technology Program is sufficient evidence of qualification for entry into the course.

Module Goal:

When this module is completed, the student will be able to competently operate a microscope under laboratory conditions.

Student Performance Objective 1:

Given access to a microscope commonly found in wastewater treatment systems, the student will identify the major parts of the microscope verbally or on a written examination with 95% accuracy.

Instructional Areas:

1. Identifying part of a microscope

    a. Eye piece
    b. Body
    c. Arm
    d. Nose piece
    e. Objective lenses
    f. Condenser
    g. Diaphragm
    h. Diaphragm adjustment lever
    i. Substage
    j. Mirror centering adjustment
    k. Mirror
    l. Substage focus
    m. Coarse/fine adjustment
    n. Built-in illuminator
    o. Base

Examples of Supporting References:

Hartley, W.G., How to Use a Microscope. Garden City, New York: The National History Press. 1964.

Examples of Student Learning Activities:

1. Given access to a microscope, the instructor may have several students turn on the built-in illuminator.
2. Given diagrams and photographs of three different type of microscopes commonly used in wastewater treatment laboratories, the instructor may ask several students to prepare reports on the specific differences between the types of microscopes.

Examples of Evaluation Techniques:

1. Given access to a microscope, the instructor may have a student correctly identify the course-fine adjustment on the microscope.
2. Given access to a microscope, the instructor may have two students remove the eye piece of the microscope in an approved manner.

Instructional Resources:

1. Access to a microscope of the type commonly used in a wastewater treatment laboratory
2. Photographs and diagrams of various types of microscopes

Student Performance Objective 2:

Given access to a microscope commonly found in wastewater treatment systems, the student will demonstrate the proper use of the microscope according to directions in given manual.

Instructional Areas:

1. Assembling the microscope

   a. Removing from the box
   b. Dislodging the dust
   c. Fitting eye pieces and objectives

2. Setting up and focusing the microscope

   a. Setting on a rigid table
   b. Racking substage condenser until the top is flush with surface of stage
   c. Placing a slide on the stage
   d. Turning the mirror with flat side uppermost

   e. Racking down the body with low power objective until front of objective is about 1/8-inch from slide
   f. Slowly rack up body to sharp focus
   g. Adjusting illumination
   h. Checking centration of the condenser
   i. Regulating amount of light
   j. Closing iris until illuminated area covers 9/10 of objective lens

3. Surveying with low power

   a. Examining specimen carefully
   b. Manipulating slide

4. Setting up medium power

   a. Removing eye piece

      (1) Opening iris diaphragm

   b. Replacing eye piece

      (1) Rotating nose piece

   c. Bringing specimen into focus
   d. Examining back of objective
   e. Adjusting radial screws
   f. Centration
   g. Adjusting substage screws
   h. Racking condenser into focus

5. Setting up high power

   a. Adjusting microscope tube
   b. Applying small bead of immersion oil to top of cover glass
   c. Lowering objective into oil
   d. Locating specimen
   e. Adjusting illumination
   f. Adjusting substage iris

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a microscope with high power adjustment and a specimen to be examined, the instructor may ask a student to bring the specimen into focus.

2. Given a microscope, the instructor may ask two students to identify the working distance of the low power objective.

Examples of Evaluation Techniques:

1. Given a microscope, the student should be able to correctly remove and replace the eye piece to the satisfaction of the instructor.
2. Given a microscope set up and adjusted for high power, the student should be able to locate the specimen.

Instructional Resources:

1. A microscope commonly found in a wastewater treatment laboratory
2. Sample slides

USING BASIC BACTERIOLOGY IN WASTEWATER TREATMENT SYSTEMS

CODE--01.99

Module Concept:

Bacteria are minute living organisms. There are many types of bacteria, some helpful to the wastewater treatment process and some harmful. Tests to determine the presence of bacteria, the number and kinds are necessary in wastewater treatment processes to control the processes. Various tests are also required to fulfill various local, state and federal regulations.

The purpose of this module is to depict for the instructor areas which should be taught relative to bacteriology in such a way that the sutdent may be able to understand bacteriology in wastewater systems and perform the various tests a wastewater treatment operator or wastewater treatment laboratory technician must perform in the course of carrying out their duties.

Prerequisites:

Courses in biology and chemistry would be helpful.

Module Goal:

When this module of instruction is completed the student will be able to use bacteriology in the understanding of wastewater treatment processes and perform the necessary water quality tests.

Student Performance Objective 1:

Given a combination of positive results in a series of fermentation tube implants, the student will demonstrate the proper use of table of "most probable numbers" with 95% accuracy.

Instructional Areas:

1. Selecting dilutions
    a. Selecting highest dilution with all positive tubes before a negative tube occurs, plus next two dilutions
    b. Record readings
2. Including positives beyond chosen dilutions if positives extend beyond three chosen dilutions
    a. Discarding unreasonable positives
3. Adding totals of the readings
4. Locating appropriate table of MPN

5. Reading results in parts per 100 ml

Examples of Supporting References:

1. Kerri Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970.

Examples of Student Learning Activities:

1. Given a list of readings from dilutions: 5 5 1 0 2, the instructor may ask two students how to handle the 2 reading.
2. Given a series of tubes used in testing for coliform bacteria, the instructor may ask several students to describe the effects of dilution in the tubes.

Examples of Evaluation Techniques:

1. Given a series of dilutions with the readings, the student should be able to correctly select the table to be read for the MPN index.
2. Given the MPN reading from the MPN index, the student should be able to examine the series of dilutions used with the given readings and correctly identify the number of zeros to be added to the information from the table.

Instructional Resources:

1. Results of fifteen tubes in the test for coliform bacteria
2. Tables for MPN index for various combinations of positive and negative results in a planting series of five 10-ml, five 1-ml, and five 0.1-ml portions of sample.

Student Performance Objective 2:

Given access to microbiological materials and equipment and the task of identifying water-borne diseases, the student will perform the various tests and procedures to identify all the commonly encountered water-borne diseases.

Instructional Areas:

1. Using a microscope
   a. Adjusting for magnification
   b. Selecting the eyepiece
   c. Turning on the light
   d. Placing the slide in the microscope
   e. Viewing the slide through the eyepiece

2. Identifying various water-borne diseases
   a. Selecting samples
   b. Preparing stains
      (1) Acid-fast stain
      (2) Flagella stain
      (3) Gram stain

   c. Determining characteristics of various water-borne diseases
      (1) Typhoid fever
      (2) Dysentery
      (3) Cholera
      (4) Gastro enteritis

Examples of Supporting References:

1. American Public Health Association. Standard Methods for the Examination of Water and Wastewater. New York: The Association. Current edition.

Examples of Student Learning Activities:

1. Given a standard microscope, the instructor may ask several students to identify the low power magnification of the given microscope.

2. Given a stain of a pathogenic organism the instructor may ask two students to explain to the class the purpose of staining.

Examples of Evaluation Techniques:

1. Given a standard microscope and sample slides of 4 common water-borne diseases, the student should be able to correctly identify all four diseases with the use of the microscope.

2. Given a stain of a pathogenic organism commonly found in a wastewater system, the student should be able to correctly identify the organism and the disease it causes.

Instructional Resources:

1. Standard microscope
2. Given manufacturer's manual for given microscope
3. Various examples of stains

Student Performance Objective 3:

Given the appropriate equipment used for performing water quality tests, the student will perform the following tests:

   a. Multiple tube fermentation test
   b. A membrane filter test
   c. Standard plate count

according to local or state water treatment standards.

Instructional Areas:

1. Performing multiple tube fermentation test
    a. Dissolving recommended amount of dehydrated medium in distilled water
    b. Dispensing solution into fermentation tubes containing an inverted glass vial
    c. Autoclaving tubes at 121 degrees F for 15 minutes

2. Performing 24-hour Lactose Broth Presumptive Test
    a. Selecting five tubes for Lactose Broth
    b. Adding 10 ml of water sample to each tube
    c. Incubating samples at 35 degrees C for 24 hours
    d. Checking for gas
    e. Reincubating negative tubes for an additional 24-hours

3. Performing 24-hour Brilliant Green Bile Confirmation Test
    a. Confirming all presumptive tubes that show gas in 24 or 48 hours
    b. Taking a loop full of broth from positive presumptive test and innoculating a green bile media
    c. Incubating at 35-37 degrees C for 24-48 hours
    d. Interpreting the results:

  - (1) If gas is produced the test is positive and water is unsafe
  - (2) If gas is not produced, the test is negative and the water is safe

4. Performing the Membrane Filter Test
   - a. Preparing the equipment
     - (1) Centering membrane filter on filter holder
     - (2) Placing funnel on to filter holder
   - b. Pouring or pipetting sample into funnel
     - (1) Applying suction
     - (2) Rinsing four times with sterile buffered distilled water
   - c. Removing membrane filter from filter holder
     - (1) Placing membrane on pad
     - (2) Covering with Petri top
   - d. Incubating in inverted position for 22 hours
   - e. Counting colonies on membrane
     - (1) Removing Petri Dish from incubator
     - (2) Removing lid from Petri Dish
     - (3) Turning so that your back is to window
     - (4) Tilting membrane filter in base of Petri Dish so that green and yellow-green colonies are most apparent
     - (5) Counting individual colonies using an overhead flourescent light
     - (6) Noting colonies with "metallic sheen"
     - (7) Reporting total number of "coliform colonies"

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a sample to be autoclaved, the instructor may ask several students to autoclave the sample for 15 minutes at 121° f.

2. Given a pair of tweezers, a bottle of alcohol and a lighted bunsen burner, the instructor may ask several students to sterilize the tweezers.

Examples of Evaluation Techniques:

1. Given a multiple tube fermentation test, the student should be able to check the inverted glass vial for gas by using approved laboratory techniques.

2. Given a Petri Dish with a membrane filter containing coliform colonies growing on it, the student should be able to count the number of colonies with 90% accuracy.

Instructional Resources:

For multitube fermentation tests:

1. Fifteen sterile tubes of lactose broth for each sample
2. Five tubes for each dilution
3. Dilution tubes containing 9 ml or 99 ml sterile buffered distilled water
4. Quantity of one and 10 ml sterile pipettes
5. Access to an incubator
6. Autoclave

For the membrane filter test:

1. One sterile membrane filter
2. One sterile Petri dish with lid
3. One sterile funnel and support stand
4. Two sterile pads
5. One receiving flask
6. Vacuum pump, trap, suction or vacuum gauge, connecting sections of plastic tubing, Glass T clamp
7. Tweezers, alcohol, bunsen burner, grease pencil
8. Sterile buffered distilled water
9. M.Endo media
10. Sterile pipettes
11. Quantity of dilution water blanks
12. Access to a moist incubator

PERFORMING VARIOUS LABORATORY TESTS IN THE OPERATION OF WASTEWATER TREATMENT SYSTEMS

CODE--01.99

Module Concept: Laboratory tests are performed in the wastewater treatment laboratory in order to fulfill various local, state and federal regulations and to control the wastewater treatment processes occuring in the system.

The purpose of this module is to depict for the instructor areas which should be taught relative to performing various laboratory tests in such a way that the student may safely perform the common tests of a wastewater treatment system by following a given set of procedures.

Prerequisites: Modules concerning basic bacteriology, chemistry, hygiene and safety in the wastewater treatment laboratory should be covered before undertaking this module.

Module Goal: At the completion of this module, the student should be able to apply basic skills in performing tests common to a wastewater treatment laboratory.

Student Performance Objective 1: Given the task of testing wastewater samples for physical characteristics with access to appropriate apparatus, reagents and procedures, the student should be able to perform the following tests and calculate mathematical problems when necessary:

- a. Temperature
- b. Turbidity
- c. Color
- d. Dissolved oxygen
- e. Conductivity
- f. pH
- g. Odor

with an accuracy within the accepted limits of good chemical practices.

Instructional Areas:

1. Testing for temperature
    a. Selecting the appropriate thermometer
    b. Following the procedures for reading a thermometer
    c. Reporting test results

2. Testing for Turbidity
    a. Obtaining appropriate sample to be tested
    b. Selecting the apparatus for performing the test
    c. Following given laboratory procedures
    d. Determining test results
    e. Reporting test results

3. Testing for color
    a. Obtaining appropriate sample to be tested
    b. Selecting the apparatus for performing the test
    c. Following given laboratory procedures
    d. Recording test results

4. Testing for dissolved oxygen
    a. Obtaining appropriate sample
    b. Selecting the apparatus for performing the test
    c. Determining the reagents necessary
    d. Following given laboratory procedures
    e. Performing necessary calculations
    f. Reporting test results

5. Testing for conductivity
    a. Obtaining appropriate sample
    b. Selecting the apparatus for performing the test
    c. Following the given laboratory procedures
    d. Reporting test results

6. Test for pH
    a. Selecting appropriate samples
    b. Selecting the apparatus for performing the test
    c. Determining the reagents necessary
    d. Following given laboratory procedures
    e. Reporting test results

7. Testing for odor
    a. Field patrolling for odor problem
        (1) Determining location of specific odor
        (2) Conducting an inspection
        (3) Conducting a community survey
    b. Measuring odors
        (1) Using Psychophysical Intensity Scale
        (2) Using quality reference standards
    c. Recording data
    d. Evaluating results of survey

Examples of Supporting References:

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970.
2. The Air Pollution Inspector. Columbus, Ohio: Ohio Agricultural Educational Curriculum Materials Service, The Ohio State University. 1974.
3. Community Odor Surveys and Evaluations. Cincinnati, Ohio: Division of Air Pollution, Robert Taft Sanitary Engineering Center. 1965.

Examples of Student Learning Activities:

1. Given a report of an odor problem, the instructor may ask several students to conduct an inspection of the site of the possible odor problem and orally report to the class the findings of the inspection.
2. Given the appropriate apparatus, reagents and samples, the instructor may ask the students to follow given procedures in performing a test for dissolved oxygen.

Examples of Evaluation Techniques:

1. Given a pond of water and an appropriate thermometer, the student will determine the temperature of the water within plus or minus one degree centigrade.

2. Given the procedures for performing the dissolved oxygen test, the student will select five pieces of laboratory equipment necessary to conduct the test.

Instructional Resources:

1. Samples to be tested
2. Appropriate apparatus for each test
3. Appropriate reagents for each test
4. Listing of procedures for each test

Student Performance Objective 2:

Given the task of testing wastewater samples for organic characteristics with access to appropriate apparatus, reagents and procedures, the student will perform the following tests and calculate mathematical problems when necessary:

- a. Biochemical Oxygen Demand
- b. Total Organic Carbon
- c. Chemical Oxygen Demand
- d. Total Nitrogen
- e. Total Phosphorous

with an accuracy within the accepted limits of good chemical practices.

Instructional Areas:

1. Testing for Biochemical Oxygen Demand
    - a. Obtaining samples to be tested
    - b. Using appropriate sample preservation techniques
    - c. Selecting the apparatus for performing the test
    - d. Determining the reagents necessary
    - e. Following given laboratory procedures
    - f. Observing exact environmental conditions
    - g. Performing necessary calculations
    - h. Reporting results

2. Testing for Total Organic Carbon
    - a. Obtaining samples
    - b. Using appropriate sample preservation techniques
    - c. Selecting the apparatus for performing the test
    - d. Following given laboratory procedures
    - e. Performing necessary calculations
    - f. Reporting results

3. Testing for Chemical Oxygen Demand
    a. Obtaining samples to be tested
    b. Using appropriate sample preservation techniques
    c. Selecting the apparatus for performing the test
    d. Determining the reagents necessary
    e. Following given laboratory procedures
    f. Observing precautions
    g. Performing necessary calculations
    h. Reporting results

4. Testing for Total Nitrogen
    a. Obtaining samples to be tested
    b. Using appropriate sample preservation techniques
    c. Selecting the apparatus for performing the test
    d. Determining the reagents necessary
    e. Following given laboratory procedures
    f. Performing necessary calculations
    g. Reporting results

5. Testing for Total Phosophorus
    a. Obtaining samples to be tested
    b. Using appropriate sample preservation techniques
    c. Selecting the apparatus for performing the test
    d. Determining the reagents necessary
    e. Following given laboratory procedures
    f. Performing necessary calculations
    g. Reporting results

Examples of Supporting References:

In addition to supporting references discussed in Student Performance Objective 1, the following will be helpful:

1. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health.

2. Standard Methods for the Examination of Water and Wastewater. American Public Health Association. Washington, D.C. (Current edition)

Examples of Student Learning Activities:

1. Given day old ferrous ammonium sulfate, the instructor may ask several students to standardize the solution for use in the Chemical Oxygen Demand test.
2. Given the procedures of a Chemcial Oxygen Demand test (COD), the instructor may ask several students to follow the written procedures in performing the COD test.

Examples of Evaluation Technqiues:

1. The student will be able to list two advantages of the COD test over the BOD test.
2. Given a sample of wastewater, a flask and concentrated sulfuric acid, the student will be able to measure within four significant figures 20 ml of sample to the flask and add within three significant figures 2 ml of concentrated sulfuric acid to the sample.

Instructional Resources:

1. Sample to be tested
2. Appropriate apparatus for each test
3. Appropriate reagents for each test
4. List of procedures for each test
5. Access to a chemical laboratory

Student Performance Objective 3:

Given the task of testing wastewater samples for chemical parameters with access to appropriate apparatus, reagents, and procedures, the student will perform the following tests and calculate mathematical problems when necessary.

a. Chloride
b. Ammonia Nitrogen
c. Nitrate Nitrogen
d. Sulfate
e. Soluble ortha Phosphates

with an accuracy within the accepted limits of good chemical practices.

Instructional Areas:

1. Testing for Chloride
    a. Obtaining samples to be tested
    b. Using appropriate sample preservation techniques
    c. Selecting the apparatus for performing the test

   d. Determining the reagents necessary
   e. Following given laboratory procedures
   f. Performing necessary calculations
   g. Reporting results

2. Testing for Ammonia Nitrogen

   a. Obtaining samples to be tested
   b. Using appropriate sample preservation techniques
   c. Selecting the apparatus for performing the test
   d. Determining the reagents necessary
   e. Following given laboratory procedures
   f. Performing necessary calculations
   g. Reporting results

3. Testing for Nitrate Nitrogen

   a. Obtaining samples to be tested
   b. Using appropriate sample preservation techniques
   c. Selecting the apparatus for performing the test
   d. Determining the reagents necessary
   e. Following given laboratory procedures
   f. Performing necessary calculations
   g. Reporting results

4. Testing for sulfates

   a. Obtaining samples to be tested
   b. Using appropriate sample preservation techniques
   c. Selecting the apparatus for performing the test
   d. Determining the reagents necessary
   e. Following given laboratory procedures
   f. Performing necessary calculations
   g. Reporting results

5. Testing soluble ortho phosphates

   a. Obtaining samples to be tested
   b. Using appropriate sample preservation techniques
   c. Selecting the apparatus for performing the test
   d. Determining the reagents necessary
   e. Following given laboratory procedures
   f. Performing necessary calculations
   g. Reporting results

Examples of Supporting References:

Supporting references were discussed in Student Performance Objectives 1 and 2.

Examples of Student Learning Activities:

1. Given a sample of water and the appropriate reagents and equipment, the instructor may ask several students to follow the necessary procedures to test for chloride in the sample.

2. Given an equiped wastewater laboratory, the instructor may ask several students to select the apparatus for testing a wastewater sample for Ammonia Nitrogen.

Examples of Evaluation Techniques:

1. Given a sample of wastewater to be tested for sulfates, the student will be able to use the appropriate preservation techniques by following approved laboratory procedures.

2. Given a known results, the student should be able to prepare an unknown standard and compare by following approved laboratory procedures.

Instructional Resources:

1. Samples to be tested
2. Appropriate apparatus for each test
3. Appropriate reagents for each test
4. List of procedures for each test
5. Access to a chemical laboratory

Student Performance Objective 4:

Given the task of testing wastewater samples for bacteriological parameters with access to appropriate apparatus, reagents and procedures, the student should be able to perform the following tests and calculate mathematical problems when necessary:

 a. Fecal Coliform
 b. Fecal Streptococcus

to within acceptable limits as determined by standard bacteriological procedures.

Instructional Areas:

1. Testing for Fecal Coliform:

    a. Obtaining samples to be tested
    b. Selecting the apparatus for performing the test

c. Determining the broth required
d. Following given laboratory procedures

    (1) Elevated temperature test
    (2) Membrane filter method
    (3) Fermentation tube method

e. Codifying results where appropriate
f. Counting membrane filter colonies where appropriate
g. Determining MPN where appropriate

2. Testing for Streptococcus

    a. Obtaining samples to be tested
    b. Selecting apparatus for performing the test
    c. Determining the reagents required
    d. Following given laboratory procedures
    e. Codifying results

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given an autoclave, the instructor may have two students demonstrate to the class the procedure for loading the autoclave.

2. Given the equipment and tubes of culture and broth, the instructor may ask two students to demonstrate the appropriate method of incubating the tubes of broth.

Examples of Evaluation Techniques:

1. The student will be able to determine the MPN of fecal coliforms per 100 ml of sample with 95% accuracy.

2. While testing for fecal coliform bacteria, the student will be able to record the gas production for each tube with 95% accuracy.

Instructional Resources:

1. Samples to be tested
2. Appropriate apparatus for each test
3. Appropriate reagents for each test
4. List of procedures for each test
5. Access to a wastewater treatment laboratory

Student Performance Objective 5:

Given the responsibility of testing wastewater samples for chemical quality with access to appropriate apparatus, reagents and procedures, the student will perform the following tests and calculate mathematical problems when necessary:

a. Chromium
b. Copper
c. Iron
d. Organics
e. Sodium
f. Zinc
g. Total Dissolved Solids

to within plus or minus 0.01 mg accuracy.

Instructional areas:

1. Using an analytical balance

2. Testing for Chromium

   a. Obtaining samples to be tested
   b. Using appropriate sample preservation techniques
   c. Selecting the apparatus for performing the test
   d. Determining the reagents required
   e. Following given laboratory procedures
   f. Performing necessary calculations
   g. Reporting results

3. Testing for Copper

   a. Obtaining samples to be tested
   b. Using appropriate sample preservation techniques
   c. Selecting the apparatus for performing the test
   d. Determining the reagents required
   e. Following given laboratory procedures
   f. Performing necessary calculations
   g. Reporting results

4. Testing for Iron

   a. Obtaining samples to be tested
   b. Using appropriate sample preservation techniques
   c. Selecting the apparatus for performing the test

   - d. Determining the reagents required
   - e. Following the given laboratory procedures
   - f. Performing necessary calculations
   - g. Reporting results

5. Testing for Organics

   - a. Using carbon analyzers
   - b. Using appropriate sample preservation techniques
   - c. Obtaining samples to be tested
   - d. Selecting the apparatus for performing the test
   - e. Following given laboratory procedures
   - f. Performing necessary calculations
   - g. Reporting results

6. Testing for Sodium

   - a. Obtaining samples to be tested
   - b. Using appropriate sample preservation techniques
   - c. Selecting the apparatus for performing the test
   - d. Following given laboratory procedures
   - e. Performing necessary calculations
   - f. Reporting results

7. Testing for Zinc

   - a. Obtaining samples to be tested
   - b. Using appropriate sample preservation techniques
   - c. Selecting the apparatus for performing the test
   - d. Determining the reagents required
   - e. Following the given laboratory procedures
   - f. Performing necessary calculations
   - g. Reporting results

8. Testing for total dissolved solids

   - a. Obtaining samples to be tested
   - b. Using appropriate sample preservation techniques
   - c. Determining suspended solids test
     - (1) Selecting the apparatus necessary
     - (2) Following given laboratory procedures
     - (3) Determining the results
     - (4) Reporting results

d. Determining total solids

  (1) Selecting the apparatus necessary
  (2) Following given laboratory procedures
  (3) Determining the results
  (4) Reporting results

e. Subtracting suspended solids from total solids for dissolved solids

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1 and 2.

Examples of Student Learning Activities:

1. Visiting a wastewater treatment laboratory, the instructor may point out to the students a carbon analyzer and explain its operation.

2. Given the procedures for analyzing a water sample for copper, the instructor may ask several students to demonstrate the method of setting up to run the test.

Examples of Evaluation Technqiues:

1. Given a sample of wastewater, the student will evaporate a sample to dryness by following the recommended laboratory procedures.

2. Given a dry sample, the student will weigh the sample within plus or minus .01 gram

Instructional Resources:

1. Samples to be tested
2. Appropriate apparatus for each test
3. Appropriate reagents for each test
4. List of laboratory procedures for each test
5. Access to a wastewater treatment laboratory

ANALYZING AND RECORDING LABORATORY RESULTS

CODE--01.99

Module Concept:	It is essential for wastewater treatment personnel to analyze and record laboratory results for the purpose of maintaining plant efficiency and making changes and improvements in plant operations. Graphical tables and charts are necessary to help the general public, as well as the board of the wastewater system to understand the costs involved in wastewater treatment operations. The purpose of this module is to depict for the instructor areas which should be taught relative to recording and analyzing the results of laboratory tests performed which will enable the wastewater treatment personnel to understand the efficiency of plant operations and be able to communicate the plant operations to the board and the general public.
Prerequisites:	This module should be undertaken after modules on the chemistry, bacteriology and tests to be performed in the laboratory have been concluded.
Module Goal:	When this module is completed, the student will be able to both record and analyze various tests performed in a wastewater treatment laboratory.
Student Performance Objective 1:	Given the task of recording laboratory test results on appropriate forms, the student will record the test results with 95% accuracy in such a way that they are readable.

Instructional Areas:

1. Determining what data is essential and useful
    a. Local, state and federal requirements
    b. Tests necessary to control plant efficiency
2. Preparing forms on which the test results can be quickly entered in proper spaces
3. Writing tests results on the forms in permanent ink
4. Preserving and filing forms where they can be located rapidly.

Examples of Supporting References:

1. Kerri, Kenneth D. Operation of Wastewater Treatment Plants. Sacramento, California: Department of Civil Engineering, Sacramento State College. 1970.
2. Manual of Instruction for Sewage Treatment Plant Operators. Albany, New York: New York State Department of Health.

Examples of Student Learning Activities:

1. After completing a laboratory test, the instructor may ask two students to record the test results on the appropriate form in the appropriate column.
2. Given the monthly total volume of a wastewater treatment system, the instructor may ask several students to prepare a report explaining why such information is important to the laboratory technician.

Examples of Evaluation Techniques:

1. Given a list of results from the multiple tube coliform bacteria tests, the student should be able to accurately record the results on appropriate given forms in such a way that the median value may be determined.
2. Given a file of laboratory test results, the student should be able to locate any given set of tests for the previous month within a reasonable time.

Instructional Resources:

1. Local, state and federal requirements for test data required
2. Samples of various forms commonly used in a wastewater treatment laboratory
3. Access to an active file in a wastewater treatment laboratory

Student Performance Objective 2:

Given information pertinent to several laboratory tests, the student will analyze and verbally interpret the test results with 95% accuracy.

Instructional Areas:

1. Determining causes of variation in test results
    - a. Actual variations in samples
    - b. Sampling procedures
    - c. Testing procedures

2. Analyzing and interpreting average value
    - a. Dividing the number of measurements by the total of the measurements
    - b. Interpreting results against given standards

3. Analyzing and interpreting the range of values
    - a. Subtracting smallest measurement from the largest measurement to find range
    - b. Determining how data fits into range

4. Analyzing and interpreting median, mode and geometric mean, standard deviation and rejection of data
    - a. Determining median by ranking measurements and finding middle measurement
    - b. Determining mode by finding the measurement that occurs most frequently
    - c. Determining geometric mean
        - (1) Converting all measurements to logarithms
        - (2) Finding average of the logarithms
        - (3) Converting average log to geometric mean from Table of Common Logarithms
    - d. Interpreting findings using common standards
        - (1) Predicting
        - (2) Explaining efficiency
    - e. Determining when to accept or reject data

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. While collecting samples for laboratory testing, the instructor may have several students point out, at the testing site, the differences in characteristics at different locations.

2. Given a list MPNs with one extremely high MPN, the instructor may ask several students to explain some possible reasons for the high MPN, and what to do with inconsistent data.

Examples of Evaluation Techniques:

1. Given the need for reliable test results, the student should be able to list three factors that can cause variations in test results.
2. Given a table of common logarithms, the student should be able to correctly identify the mantissa.

Instructional Resources:

1. Sampling equipment
2. Appropriate protective clothing
3. List of standards for given tests
4. Table of Common Logarithms
5. A list of MPN from a multiple tube coliform bacteria test

Student Performance Objective 3:

Given data regarding various laboratory test results, the student will prepare tables, graphs, and charts which illustrate trends and changes in the wastewater treatment processes with 95% accuracy.

Instructional Areas:

1. Preparing tables
    a. Determining data necessary
    b. Determining columns and headings
    c. Writing data in order, descending or ascending
2. Preparing graphs
    a. Bar graphs
        (1) Grouping the data
        (2) Determining the class midpoints
        (3) Determining the frequency
        (4) Plotting the results
    b. Line graphs
        (1) Determining value interested in

    (2) Determining against what value is measured
    (3) Plotting the value

3. Preparing charts
    a. Determining data necessary
    b. Determining which tables and graphs to utilize
    c. Determining the narration
    d. Preparing the chart

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a normal distribution of data on a line graph, the instructor may ask several students to locate the average on the graph.

2. Given sample line graphs from a wastewater laboratory, the instructor may ask several students to explain to the class what the line graphs illustrate.

Examples of Evaluation Techniques:

1. Given graphs commonly used in wastewater treatment laboratories, the student should be able to list at least two reasons why graphs are used.

2. Given a list of weekly alkalinity tests on influent, the student should be able to accurately plot the test results on a line graph showing a period of ten weeks.

Instructional Resources:

1. Samples of line and bar graphs commonly used in a wastewater treatment laboratory
2. List of weekly alkalinity test on influent
3. Access to a wastewater treatment laboratory
4. Sample of tables and charts

PERFORMING GENERAL OFFICE DUTIES

CODE--01.99

Module Concept: In most supervisory and technical positions the personnel are required to perform some office tasks as part of their duties. The performance of office duties in a professional manner is a matter of good public relations as well as effectively getting the telephones answered, letters written and forms filed.

The purpose of this module is to depict for the instructor areas which should be taught relative to performing general office duties in such a way that the student will understand the technical aspects of performing general office duties in a professional manner.

Prerequisites: Admission to any supervisory or technical course is sufficient evidence of qualifications for entry into this course. Basic courses in English would be helpful.

Module Goal: When this module is completed, the student will be able to perform general office duties.

Student Performance Objective 1: Given access to a common type of office setting, the student will:

a. Answer the telephone
b. Clearly converse on the telephone
c. Take telephone messages accurately
d. Place calls on the telephone
e. Prepare and mail a business letter
f. File various forms and reports
g. Keep the office clean and organized

by following procedures of accepted general office practices.

Instructional Areas:

1. Answering the telephone

    a. Answering before the third ring
    b. Identifying ones' self
    c. Listening carefully to the caller
    d. Speaking clearly and distinctly
    e. Being friendly
    f. Keeping a pad of paper and pencil near the phone
    g. Taking messages accurately

        - (1) Name of caller
        - (2) Company name
        - (3) Telephone number
        - (4) Time of call
        - (5) Giving messages to person called without delay

    - h. Answering questions and returning calls promptly

2. Placing phone calls

    - a. Using the telphone directory
    - b. Deciding what to say before placing calls
    - c. Letting ring ten times
    - d. Identifying yourself immediately
    - e. Stating purpose of call succinctly
    - f. Placing long distance calls

        - (1) Station-to-station
        - (2) Person-to-person

3. Using mail correspondence

    - a. Organizing a letter
    - b. Writing a rough draft
    - c. Writing in a neat manner without mistakes
    - d. Addressing the envelope
    - e. Sending the letter with appropriate postage attached

4. Using general office filing systems

    - a. Identifying methods of filing

        - (1) Subject matter
        - (2) Alphabetical
        - (3) Chronological
        - (4) Numerical

    - b. Arranging files
    - c. Filing information
    - d. Locating needed information

5. Keeping office clean and organized

    - a. Setting aside a place for in-going and out-going information
    - b. Organizing work
    - c. Straightening up desk at the end of the work day

Examples of Supporting References:

1. Public Relations for Water Pollution Control. Water Pollution Control Federation. WPCF Publication No. 12. Washington, D.C. 1965.
2. The Secretary's Manual. New York City, New York: The New American Library, Inc. 1968.

Examples of Student Learning Activities:

1. Given a model telephone, the instructor may have one student play the role of the caller and one student the role of answering the phone.
2. The instructor may ask a trained office secretary to visit the class and discuss the use of the telephone and letter writing procedures.

Examples of Evaluation Techniques:

1. Given the task of writing a business letter concerning a given problem, the student should be able to write the business letter neatly with not more than two mistakes.
2. Given a telephone directory and a list of 10 names and/or companies, the student should be able to locate the individual and/or company name and record the phone numbers with 90% accuracy within 15 minutes.

Instructional Resources:

1. Model telephone
2. Telephone book
3. Samples of business letters
4. Access to an office filing system
5. Writing paper and envelopes
6. Access to an office desk with office materials on and in the desk

USING LABORATORY STATISTICS

CODE--01.99

Module Concept:

The Wastewater Treatment Laboratory Technician must be able to make measurements and interpret experiments. It is important to make sharp predictions with the assistance of statistical techniques.

The purpose of this module is to depict for the instructor areas which should be taught relative to statistics which will enable the Wastewater Treatment Laboratory Technician to be able to understand and use statistical terms in the wastewater treatment laboratory.

Prerequisites:

This module should be undertaken after modules on mathematics, chemistry, bacteriology and performing the various tests have been completed.

Module Goal:

When this module is completed, the student should be able to understand and use the following statistical terms: Arithmetic mean, geometric mean, standard deviation and confidence limits.

Student Performance Objective 1:

Given the task of making measurements and interpreting experiments in a laboratory, the student will understand and use the following statistical terms:

a. Arithmetic mean
b. Geometric mean
c. Standard deviation
d. Confidence limits

with an accuracy within the accepted limits of good statistical practices.

Instructional Areas:

1. Understanding and using the arithmetic mean
    a. Computing by dividing the sum of a set of terms by the number of terms
    b. Arguments against using the arithmetic mean
        (1) Not best method of precision
        (2) Leads to different estimates of the precision
2. Understanding and using the geometric mean
    a. Determining the exact middle of two numbers
    b. Determining normal law of error

3. Understanding and using standard deviation
    a. Extracting the square root of the variance and obtaining a unit in the same scale as the original measurements
    b. Setting up statistical tables in terms of variance
    c. Using symbols
        (1) μ
        (2) σ
    d. Effective method of pooling information
    e. Calculating standard deviation
        (1) Dividing "sum of the squares" by "degrees of freedom"
        (2) Taking square root of the quotient

4. Understanding and using confidence limits
    a. Reducing the chance of erroneous prediction to any desired level
    b. Reasonable number of measurements must be made
    c. Statistically predicting confidence limits within which the average should lie

Examples of Supporting References:

1. Youden W.J. Statistical Methods for Chemists. New York, New York: Wiley and Sons, Inc. 1951.

Examples of Student Learning Activities:

1. Given a set of measurements, the instructor may have several students place the measurements on a bell graph.

2. The instructor may ask a student to give an example of a confidence limit.

Examples of Evaluation Techniques:

1. The student will be able to correctly explain the use of the symbols μ and σ .

2. Given a bell curve graph, the student will be able to determine the average within 5% of the correct average.

Instructional Resources:

1. Textbook covering statistical methods
2. Exercises using statistical methods for the student to work out
3. Examples of graphs

EXAMPLES OF MODULES FOR PREPARING
AGRICULTURAL EQUIPMENT MECHANICS

(SEE THE LIST OF STUDENT PERFORMANCE OBJECTIVES FOR
THE LOCATION(S) OF MODULES NOT FOUND HERE)

MODULE OF INSTRUCTION

CODE--01.0301

SELECTING, USING AND CARING FOR TOOLS AND EQUIPMENT IN AGRICULTURAL EQUIPMENT MECHANIC SHOPS

Module Concept: The proper selection, use, and care of hand and power tools when servicing and repairing agricultural equipment not only will aid in performing the service or repairs in an efficient and effective manner, but the proper use and care of the tools will also aid in extended tool life. In addition, using the proper tools and equipment for the designated task will help decrease operating problems in the equipment and minimize damages.

Prerequisites: Admission in the Agricultural Mechanics program is sufficient evidence of qualifications for undertaking this module.

Module Goal: Upon completion of this module the student should be able to select, use and care for tools and equipment used in servicing and repairing agricultural equipment.

Student Performance Objective 1: Given various types of tool-fittings and cold-metal tools used in repairing agricultural equipment, the student will correctly identify the tools and demonstrate their uses with 95% of the tools given as presented in a tool catalogue such as published by tool distributing companies and to the satisfaction of the instructor or a person he/she designates.

Instructional Areas:

1. Identifying various types of tool-fitting and cold metal tools and their uses

    a. Clear face shield
    b. Handled wire brush
    c. File cleaning brush
    d. Bevel sickle stone
    e. Scythe stone
    f. Carborundum stone
    g. Grit grinding wheel
    h. Emery wheel dresser
    i. Various types files (e.g. flat mill bastard file, round, mill bastard two-round edges file)

- j. Die stock
- k. Tap wrenches
- l. Various types of hexagon bolt threaders
- m. Various types of bolt dies
- n. Adjustable frame hack saw
- o. End cutting nippers
- p. Linemen's pliers
- q. Ball pen hammers and various types of cold chisels
- r. Various sizes of metal "C" clamps
- s. Various sizes bolt cutters
- t. Heavy duty portable drill
- u. Various types of punches
- v. Various types of shanks
- w. Various sizes of taps

2. Selecting and using a power grinder

   - a. Checking the location and condition of motor
   - b. Adjusting guards
   - c. Checking condition of pulleys
   - d. Protecting motor from abrasive dust
   - e. Selecting grinding wheel by considering

     1. Grit size
     2. Diameter size
     3. Arbor hole
     4. Speed of grinding wheel in rpm

   - f. Using safety practices while operating grinder

     1. Protecting eyes with goggles
     2. Keeping the guard adjusted as near the wheel as possible
     3. Keeping tool rest adjusted within correct distance of the grinding wheel
     4. Keeping the grinding wheel true by frequent dressing
     5. Using the curved face of the wheel for grinding
     6. Running wheel at speed recommended by manufacturer
     7. Tightening grinder wheel securely to the arbor with appropriate tool and the grinder to the table or pedestal
     8. Applying the stock or tool slowly to the grinding wheel when using
     9. Replacing grinding wheel when needed with appropriate tool

g. Sharpening tools and agricultural equipment with electric grinder such as;

1. Screw-driver
2. Cold chisel
3. Twist drill
4. Mower knife

3. Selecting and using other types of tool-fitting and cold metal tools (a listing of the equipment was depicted earlier) used in repairing agricultural equipment such as:

1. C-clamps
2. Portable drill
3. Bolt cutters

Examples of Supporting References:

1. Wakeman, T.J., and McCry, Vernon Lee. *The Farm Shop*. New York: The Mac Millan Company, 1960.

Examples of Student Learning Activities:

1. The instructor may have students quiz each other using actual tools or flash cards of tools. The students should make certain the proper and/or common name of the tool is used and the use or purpose of the tool is described.

2. The instructor may desire to place several types of tool fitting and cold metal tools on a table and have students identify the tools verbally and/or by writing down the names on paper.

3. The instructor may desire to have each student in the class use the electric grinder to sharpen screw-drivers, cold chisels or other appropriate tool-fitting equipment.

Examples of Evaluation Techniques:

1. Given access to tool-fitting and cold metal tools, students should be capable of identifying 95% of the tools given by writing down the common names.

2. Given access to tool-fitting and cold metal tools, students should be capable of verbally explaining the uses of 95% of the equipment given in laymen terms.

3. Given access to several sizes of bolt cutters and a bolt which needs to be cut, students should be capable of selecting the appropriate size bolt cutter and cut the bolt so well that is completely separated.

Instructional Resources:

1. A complete list of tool-fitting and cold metal tools used in servicing and repairing agricultural equipment
2. Metals of various sizes and types for the students to work with
3. Charts and flash cards showing various tool-fitting and cold-metal tools
4. Tool and equipment catalogues from various tool and equipment distributing firms
5. Operator's manuals for power equipment
6. Access to an agricultural equipment mechanic shop

Student Performance Objective 2:

Given various types of machinery maintenance tools used in repairing and servicing agricultural equipment, the student will correctly identify the tools and demonstrate their uses with 95% of the tools given as presented in a tool catalogue such as published by tool distributing companies and to the satisfaction of the instructor or a person he/she designates.

Instructional Areas:

1. Identifying various types of machinery tools and their uses
    - a. Anti-freeze tester and battery charger
    - b. Battery Hydrometer and cell analyzer
    - c. Compression gauge
    - d. Spark plug wrenches and handles (for tractors and other farm power equipment)
    - e. Feeler gauge
    - f. Tire valve tool
    - g. Gauge for tractor tires and farm equipment
    - h. Battery strap and voltmeter
    - i. Glass cutter
    - j. Putty knife
    - k. Slip joint pliers
    - l. Battery pliers
    - m. Needle nose pliers
    - n. Monkey wrenches

o. Box end wrenches and torque wrench
p. Box and open end wrenches
q. Adjustable open end wrenches
r. Reversible ratchets
s. Speed wrench and four-way lug wrench
t. Universal joints
u. Flexible head extension
v. Extension bars
w. Various size sockets
x. Lubrication equipment
y. Auxiliary battery cables
z. Socket testing lamps and extension light and cord

2. Selecting and using various types of machinery tools (a list of tools used in repairing and servicing farm machinery were recently listed) such as:

    a. Torque wrench
    b. Feeler gauge
    c. Voltmeter
    d. Reversible ratchet

Examples of Supporting References:

In addition to the references listed in Student Performance Objective I, the following may be helpful:

1. Tool Identification Manual. San Luis Obispo, California: Vocational Education Productions, California State Polytechnic College. 32 pages.

2. Tractor Maintenance - Principles and Procedures. Athens, Georgia: Engineering Center, American Association for Vocational Instructional Materials 1970, 152 pages.

Examples of Student Learning Activities:

1. Given access to a battery and cell analyzer, the instructor may desire to have several students analyze the condition of the battery cells with the cell analyzer.

2. Given several spark plugs and a feeler gauge, the instructor may have students check and adjust gap on spark plugs as recommended by manufacturer.

3. Given access to a farm tractor and lubricating equipment, the instructor may have several students lubricate the farm equipment as recommended by the manufacturer.

Examples of Evaluation Techniques:

1. Given access to a farm tractor with rubber tires and a gauge for determining pressure in tires, the students should be capable of using the gauge in determining the pressure in the farm tractor tires with 95% accuracy.

2. Given several bolts to be tightened on farm equipment and a variety of wrenches, the students should be able to select the appropriate type and size wrench and tighten the bolts so well that the equipment can withstand normal operating conditions.

Instructional Resources:

1. A complete line of tools used in repairing and servicing agricultural equipment.

2. Agricultural equipment which has various sizes and types of bolts.

3. Tools and equipment catalogues from various tools and equipment distributing firms.

4. Access to an agricultural equipment mechanic shop.

5. Charts and flash cards showing various types and sizes of tools used in repairing and servicing agricultural equipment.

Student Performance Objective 3:

Given various types of equipment used in repairing and servicing agricultural equipment to be cared for and stored, the students will care for and store the equipment so that the equipment will operate properly when used and is stored to the satisfaction of the instructor or a person he/she designates.

Instructional Areas:

1. Arranging and storing tools and equipment used in repairing and/or servicing agricultural equipment
   a. Establishing a location in the shop for repairing and servicing machinery
   b. Arranging various work areas in the shop
      1. Oxy-acetylene and arc welding areas
      2. Tool-fitting and cold metal panels
      3. Machinery maintenance tools panel
      4. Woodworking panel
      5. Washing area
      6. Work benches with vises and grinders
      7. Drill press
      8. Machinery storage area
      9. Supplies and spare parts storage area

- c. Placing and securing tools and equipment in desired areas
- d. Using safety practices while placing and securing tools and equipment

2. Caring for tools and equipment used in repairing and/or servicing agricultural equipment

    - a. Cleaning tools and equipment with appropriate solutions
    - b. Oiling and greasing desired equipment when needed
    - c. Using safety practices while caring for tools and equipment
    - d. Testing tools and equipment for proper operation
    - e. Inspecting tools and equipment for conditions

3. Cleaning the shop

    - a. Selecting cleaning equipment and materials for cleaning the shop
        1. Manual equipment
        2. Mechanical equipment
    - b. Using cleaning equipment and materials for cleaning the shop
        1. Sweeping floors
        2. Washing down floors
        3. Cleaning equipment and tables
    - c. Storing unwanted materials in appropriate containers

Examples of Supporting References

1. Examples of supporting references were depicted in Student Performance Objective I and 2

Examples of Student Learning Activities:

1. The instructor may desire to arrange various types of machinery maintenance tools on a table and have several students properly arrange the tools on a specified panel in the shop.

2. Given access to various types of power equipment used in repairing and servicing agricultural equipment, the instructor may have students lubricate equipment according to manufacturer's directions.

Examples of Evaluation Techniques:

1. Given the task of arranging agricultural equipment which has to be repaired in a shop, the students should be capable of arranging the equipment in the shop so well that the equipment can be repaired properly and safely.

2. Given the task of cleaning an area in the agricultural equipment repair and service shop, the student should be able to select the appropriate equipment and clean the area given to the satisfaction of the instructor.

Instructional Resources:

1. A complete line of tools used in repairing and servicing agricultural equipment.

2. Access to an agricultural equipment repair and service shop.

3. Brooms, brushes and other cleaning materials and equipment usually found in an agriculture equipment repair and service shop.

MODULE OF INSTRUCTION

CODE--01.0301

OPERATING OXY-ACETYLENE WELDING EQUIPMENT

Module Concept: Oxy-acetylene equipment utilizes acetylene and oxygen to produce a flame that melts metal and filler rod which produces a repair in broken or damaged agricultural equipment. The Agricultural Equipment Mechanic must be able to use oxy-acetylene equipment to perform a satisfactory job of welding in order to prevent further damage to agricultural equipment.

The purpose of this module is to depict for the instructor areas which should be taught relative to oxy-acetylene welding to enable the student to effectively and safely operate oxy-acetylene equipment in performing simple welding operations.

Prerequisites: The following modules should be studied before this module is undertaken:

1. Using Safety and Sanitation Practices in Agricultural Equipment Mechanic Shops
2. Selecting, Using and Caring for tools and Equipment used in Agricultural Equipment Mechanic Shops
3. Operating Arc Welding Equipment, especially the instructional area pertinent to identifying common metals used in making minor repairs on agricultural equipment

Module Goal: At the completion of this module, the student will be able to apply basic oxy-acetylene welding skills and knowledges in making minor repairs on agricultural equipment.

Student Performance Objective 1: Provided the appropriate oxy-acetylene welding equipment and pieces of steel or cast iron of various thickness, the student will cut steel or cast iron well enough that the pieces fit intended purpose as determined by the instructor.

Instructional Areas:

1. Setting up the oxy-acetylene welding equipment

    a. Placing cylinders in a cart
    b. Fastening cylinders in a manner to prevent tipping over while using
    c. Removing the caps from cylinders
    d. Cracking the cylinder valves to blow out all dust and other foreign matter
    e. Using appropriate cloth to remove mud or dirt from the connections when feasible
    f. Preventing damages to clothes or body when setting up the equipment
    g. Replacing the iron cap on the cylinders when the regulator is removed
    h. Removing dust caps and connecting the acetylene regulator to the acetylene cylinder
    i. Connecting oxygen regulator to the oxygen cylinder
    j. Setting the regulator in an upright position with the gauges facing the front
    k. Attaching fittings to each end of the hoses
    l. Connecting the green and red hoses to the appropriate attachments
    m. Using appropriate procedures in closing regulator valves before opening the cylinder valves to prevent damage to the regulator
    n. Opening the oxygen cylinder valve as recommended by manufacturer
    o. Using appropriate procedures in opening the acetylene valve with the T-wrench
    p. Opening both valves on the torch to desired opening
    q. Screwing the oxygen regulator valve in the correct direction until desired pressure is reached on the oxygen low pressure gauge and closing the oxygen valve on the torches
    r. Screwing the acetylene regulator in the correct direction until desired pressure is reached on the acetylene low pressure gauge and closing the acetylene valve on the torch
    s. Testing for leakage by applying soapy water around the valves and connections

2. Starting various types of torches and cutting steel and cast iron

    a. Starting the oxy-acetylene torch

(1) Opening the acetylene valve on the torch for the desired opening
(2) Using correct techniques in lighting the tip with a friction lighter
(3) Opening the acetylene regulator valve on the tank until desired pressure is obtained
(4) Putting on goggles
(5) Opening the oxygen valve on the torch until the preheat flames are adjusted to a neutral point
(6) Controlling the oxygen pressure

b. Starting the oxy-propane torch

(1) Opening the main valve on the propane tank to the desired opening
(2) Opening the main valve on the oxygen tank
(3) Turning the propane-tank diaphragm until the gauge registers the desired amount of propane for the specific size of tip being used
(4) Turning the oxygen regulator until the gauge registers the desired amount for the specific size of tip being used
(5) Opening the propane control knob for desired opening
(6) Opening the oxygen control knob for desired opening
(7) Lighting the flame with a flint lighter
(8) Opening the oxygen control valve until the flame is pulled back to the tip and a neutral flame is obtained
(9) Making adjustments when the flame does not come back to the tip
(10) Turning the oxygen control knob until a neutral flame is obtained

c. Cutting steel

(1) Placing a piece of ½" flat iron over the edge of the table about 2"
(2) Making a mark about 1" from the end with a piece of soapstone
(3) Putting on goggles and gloves
(4) Lighting the torch
(5) Adjusting flame
(6) Selecting proper-sized tip and regulator pressure for different thicknesses of metal

(7) Using correct procedures in grasping the torch
(8) Using appropriate techniques in heating metal
(9) Cutting the metal
(10) Using a chisel and hammer to remove any remaining slag on the edge of the cut

d. Cutting Cast Iron

(1) Adjusting the torch to an excess acetylene flame
(2) Using correct procedures and techniques in preheating cast iron
(3) Using correct procedures and techniques in cutting cast iron

Examples of Supporting References:

1. Wakeman, T. J., and McCoy, Vernon Lee. The Farm Shop. New York: MacMillan Company 1960. 597 pages

2. Welding and Cutting Manual: How to Use Your Oxy-Acetylene Outfit. New York, New York: Division of Union Carbide Corporation, Linde Company, 1949, 208 pages

3. Phipps, Lloyd James: Farm Mechanics Text and Handbook. Danville, Illinois: The Interstate Printers and Publishers, Inc. 1964

Examples of Student Learning Activities:

1. While working in the shop, the instructor may have several students place oxy-acetylene cylinders in a cart and fasten the cylinders in a manner to prevent tipping over while in use.

2. The instructor may have several students prepare a soapy water solution and use the solution to test for leaks on the oxy-acetylene equipment.

3. The instructor may have each student in the class demonstrate the correct procedures in starting the oxy-acetylene torch.

4. Given the appropriate oxy-acetylene welding equipment and a piece of steel to be cut, the instructor may have each student cut the steel with the use of the oxy-acetylene equipment.

Examples of Evaluation Techniques:

1. Given the task of connecting the green and red hoses to the appropriate outlet connections on the torch, the student should be able to connect the hoses to the correct outlet connections on the torch so well that leaks are prevented and the connections are made according to manufacturer's directions.

2. Given access to oxy-acetylene equipment, the student should be able to light the torch with a flint lighter so well that the torch continues to burn and the student's body is not injured.

3. Given access to oxy-acetylene equipment, the student should be able to open the oxygen valve on the torch in a manner that the preheat flames are adjusted to a neutral point.

4. Given a chisel, hammer and a piece of steel recently cut with the oxy-acetylene equipment which has slag on the edge of the cut, the student should be able to remove the slag with the use of the chisel and hammer so well that the piece of steel cut fits its intended purpose.

Instructional Resources:

1. Different types of metals of varying thickness for the student to work on
2. A sufficient number of oxy-acetylene welders for number of students enrolled
3. Oxy-acetylene welding accessories including gloves, goggles, clamps, pliers, chisels, hammers, friction igniters, tip cleaners, welding tables, welding rods, and tips of various sizes for cuttings
4. Vises
5. Wire brushes
6. Charts showing tip sizes to use and pressure settings to use for various situations

Student Performance Objective 2:

Given various types of metals to be welded and the appropriate welding equipment, the student will perform fillet welds in various positions that when the following welding processes are completed

a. Welding with steel rods
b. Bronze welding
c. Welding cast iron
d. Hardsurfacing
e. Fusion welding without a rod

the metals welded will be of sufficient strength for the required operating conditions as determined by the instructor.

Instructional Areas:

1. Welding with steel rods
   a. Practicing several basic tasks before welding with a steel rod
      (1) Placing metals on table which are to be welded with desired spacing
      (2) Putting on goggles
      (3) Lighting torch
      (4) Adjusting flame
      (5) Tacking welding joints
      (6) Heating metal to a molten temperature

   b. Using a steel rod in performing various types of butt welds in the flat position
      (1) Square butt weld
      (2) Single-vee butt weld
      (3) Double-vee butt weld

   c. Using a steel rod in performing single-vee butt welds in other positions
      (1) Making horizontal welds
      (2) Performing vertical welds
      (3) Performing overhead welds

   d. Using a steel rod in performing fillet welds in other positions
      (1) Lap welds
      (2) Tee-Joint welds

2. Bronze-Welding
   a. Preparing the metal for bronze welding
      (1) Cleaning metal by grinding with electric grinder
      (2) Brush with wire brush
      (3) Scraping with appropriate equipment
      (4) Tinning the metal by covering the surface to be welded with bronze

   - b. Bronze-welding in flat position
   - c. Bronze-welding in vertical position

3. Welding cast iron

   - a. Using the bronze rod in welding cast iron in various positions
   - b. Using a cast iron rod in welding cast iron in various positions

4. Hardsurfacing farm machinery

   - a. Cleaning metal to be hardsurfaced by grinding, filing, or brushing with a wire brush
   - b. Removing all grease, oil and other foreign matter with appropriate cleaning materials
   - c. Placing metal to be hardsurfaced in an appropriate location in a flat position
   - d. Heating metal
   - e. Adding enough rod to form a casting
   - f. Removing slag

5. Fusion welding without a rod

   - a. Placing metal on welding table in desired position
   - b. Putting on goggles, lighting torch and adjusting flame
   - c. Tacking metals together to prevent warping and spreading
   - d. Fusing the metals
   - e. Repeating the fusion process until weld is uniform in width and height

Examples of Supporting References:

Supporting References were depicted in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given access to gas welders, the instructor may have student light and adjust the flame on the gas welders.

2. Given access to gas welders and pieces of metals, the instructor may have students demonstrate the appropriate techniques of heating the metals.

3. Given access to gas welders, pieces of steel and rods, the instructor may have students demonstrate the techniques for performing a square butt weld in the flat position.

4. Given access to gas welders, pieces of metals and bronze rods, the instructor may have students weld metals together by using the given equipment and materials.

5. Given access to gas welders and pieces of cast iron, the instructor may have students heat the cast iron pieces until they are cherry red with the gas welder

6. Given access to gas welders, plow shares and appropriate rod, the instructor may have students hardsurface the plow shares with the gas welder and rod.

Examples of Evaluation Techniques:

1. Given access to gas welders, steel rods and pieces of metals, students should be able to square butt weld the metals in a flat position so well that they are able to withstand normal operating conditions.

2. Given access to gas welders and the task of bronze-welding pieces of farm machinery, the students should be able to select the correct bronze rods as recommended by the manufacturer.

3. Given access to gas welders, flux, cast iron rod and pieces of cast iron the students should be able to flat weld cast iron pieces so well that they are able to withstand normal operating conditions and is performed to the satisfaction of the instructor.

4. Given access to gas welders, plow shares and hardsurfacing rods, the students should be able to hardsurface the plowshares to the satisfaction of the instructor.

Instructional Resources:

1. Adequate number of gas welders for number of students enrolled
2. Pieces of flat iron of varying thickness
3. Various sizes of welding tips
4. Various sizes of steel rods
5. Electric grinder
6. Oxy-acetylene welding accessories including gloves, goggles, clamps, pliers, chisels, hammers, friction igniters, tip cleaners, welding tables, wire brushes
7. Charts showing tip sizes to use and pressure settings to use for various situations

8. Various sizes of bronze rods
9. Scrap pieces of cast iron
10. Flux
11. Plow shares

Student Performance Objective 3: Given access to gas welding equipment, accessories and various types of metals to be welded or cut, the student will apply safety practices while performing various types of welds or cuttings which will prevent injury to the body, other workers or damage to the equipment as determined by the instructor.

Instructional Areas:

1. Protecting human bodies while cutting or welding
    a. Wearing proper nongreasy clothing without cuffs
    b. Wearing proper gloves
    c. Wearing appropriate goggles
    d. Keeping tip pointed away from body to prevent saturating clothes with gas before lighting
    e. Treating body and eyes with recommended solutions when needed
    f. Keeping the tip pointed away from body when lighting

2. Preventing explosions
    a. Checking for leaks daily with soapy water
    b. Keeping flame and heat away from tanks
    c. Opening valve on the acetylene tank no more than one full turn so that it can be closed quickly
    d. Keeping safety caps on tanks when regulators are not attached
    e. Subjecting hose to only the required pressure
    f. Using only hoses which are in good condition
    g. Keeping acetylene cylinder in upright position

3. Using care around combustible materials
    a. Cleaning shop of combustible materials frequently
    b. Covering containers of flammable materials or removing before welding
    c. Keeping flame away from flammable materials
    d. Laying down torch only after flame is out
    e. Placing hot metal in protected area
    f. Preventing using any kind of oil on any part of the welding equipment

   g. Using safety practices in handling tanks

4. Protecting from gases and flames
   a. Ventilating shop properly when welding or cutting
   b. Utilizing forced ventilation when welding and cutting in confined areas

Examples of Supporting References:

Supporting references were shown in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given access to gas welding equipment and soapy water the instructor may have students check the equipment for leaks.

2. The instructor may desire to have several students clean the welding booths in the laboratory

3. The instructor may have several students demonstrate the proper techniques in wearing welding clothes, gloves and goggles.

Examples of Evaluation Techniques:

1. Given access to gas welders which are to be relocated, the students should be able to relocate the gas welders to the satisfaction of the instructor.

2. Given access to gas welders and torch igniters, students should be capable of lighting torches so well that the torches remain lighted without body injuries.

Instructional Resources:

1. Access to gas welders and shop
2. Oxy-acetylene welding accessories including gloves, goggles, friction igniters
3. Soapy water
4. Brooms and brushes for cleaning the shop laboratory
5. Containers for combustible materials

MODULE OF INSTRUCTION

CODE--01.0301

OPERATING ARC WELDING EQUIPMENT

Module Concept:

The Agricultural Equipment Mechanic must be able to use arc welding equipment to repair agricultural equipment. To perform a satisfactory job of arc welding, the person needs to develop certain skills and gain knowledges of equipment and materials used in arc welding and types of metals from which agricultural equipment is made.

The purpose of this module is to depict for the instructor areas which should be taught relative to using arc welding equipment for repairing farm equipment so that the student will be able to effectively operate arc welding equipment in making minor repairs on agricultural equipment.

Prerequisites:

The following modules should be studied before this module is undertaken:

1. Using Safety and Sanitation Practices in Agricultural Equipment Mechanic Shops
2. Selecting, Using and Caring for Tools and Equipment used in Agricultural Equipment Mechanic Shops

Module Goal:

When this module of instruction is completed, the student will be able to apply basic arc welding skills and knowledges in making minor repairs on agricultural equipment.

Student Performance Objective 1:

Given a specified number of metals found in agricultural equipment, the student will identify 95% of the metals by their common names as determined by the instructor or by an individual he/she designates.

Instructional Areas:

1. Identifying metals by observation
    a. Examining the nature and type of break

   - b. Observing the color of the grain
   - c. Listening to the ring of the metal
   - d. Examining surface appearance

2. Identifying metals by texture

   - a. Examining the type of grain
   - b. Examining the color of grain
   - c. Determining the surface of the fracture

3. Identifying metals by using the spark test

   - a. Determining the color of the spark stream

     - (1) White
     - (2) Yellow
     - (3) Straw to orange

   - b. Determining the design of the spark stream

     - (1) Bud break arrow
     - (2) Fork
     - (3) Dashes
     - (4) Shaft
     - (5) Stream
     - (6) Sprigs
     - (7) Appendages

Examples of Supporting References:

1. Kugler, Harold L. Arc Welding Lessons. The James P. Lincoln Arc Welding Foundation. P.O. Box 3035, Cleveland, Ohio. 4417. 1957.

2. Wakeman, T.J., and McCoy, Vernon Lee. The Farm Shop. New York: The MacMillan Company, 1960.

Examples of Student Learning Activities:

1. Given a plowshare, the instructor may ask several students to examine the plowshare and identify the metal from which it is made.

2. Given an electric grinder and a piece of metal, the instructor may ask several students to conduct a spark test on the metal and determine the type of metal from the spark test.

Examples of Evaluation Techniques:

1. Given five pieces of agricultural equipment made from five different metals with the grain of the metal visible, students should be able to identify at least four of the metals by their common names.

2. Given three pieces of different metals, students should be able to indicate whether two of the metals can be welded by using an arc welder.

Instructional Resources:

1. A plowshare
2. Electric grinder and appropriate protective equipment and clothing
3. Five pieces of agricultural equipment, each made from a different type of metal
4. Three pieces of metal that can be welded with an arc and three pieces of metal that cannot be welded with an arc

Student Performance Objective 2:

Given a task of welding two pieces of metal together and the appropriate arc welding equipment, the student will perform the following tasks to produce a weld of sufficient strength for the required operating conditions and satisfaction of the instructor or a person he/she designates:

a. Prepare the metal for welding
b. Select the appropriate electrode
c. Select and adjust the proper current setting
d. Strike the arc
e. Maintain the proper arc length
f. Maintain the proper speed of travel
g. Run a bead

Instructional Areas:

1. Preparing the metal for welding

    a. Removing dirt and grease
    b. Using appropriate materials in removing rust
    c. Operating electrical grinder in grinding where necessary
    d. Setting up the pieces to be welded by:

        (1) Controlling expansion and contraction
        (2) Minimizing distortion

2. Selecting the proper electrode
    a. Identifying electrodes as coded
    b. Using pocket-sized electrode guides
    c. Determining electrode size required
    d. Determining the type of coating required
        (1) Mild steel
        (2) High carbon low alloy steel
        (3) Cast iron
        (4) Hard facing

3. Selecting and adjusting the proper current setting when:
    a. Welding mild steel
    b. Welding cast iron
    c. Cutting and grooving
    d. Hardsurfacing
    e. Using a carbon-arc torch

4. Striking an arc
    a. Scratching
    b. Tapping

5. Maintaining correct arc length
    a. Pre-heating with a long arc
    b. Holding arc length of approximate diameter of electrode during welding
    c. Holding electrode angle 15° to 20° in direction of travel perpendicular to metal

6. Maintaining proper speed of travel
    a. Producing a bead 1½ times width of diameter of electrode
    b. Weaving or oscillating movement for wider beads

7. Running a bead
    a. Maintaining proper length of arc
    b. Maintaining proper forward travel
    c. Following a straight line
    d. Recognizing a good bead

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may have several students select the appropriate electrode for welding a given type of mild steel.
2. Given a piece of dirty and greasy broken agricultural equipment, the instructor may have two students clean the equipment in preparation for welding using the appropriate cleaning equipment and cleaning solutions.

Examples of Evaluation Techniques:

1. The student should be able to use a pocket electrode guide in selecting an electrode for welding a given type of mild steel to the satisfaction of the instructor.
2. Given appropriate welding equipment and electrode, the student should be able to demonstrate the proper speed of travel in welding by running a bead that is 1½ times the width of the electrode to the satisfaction of the instructor.

Instructional Resources:

1. Two pieces of metal to be welded
2. Arc welder
3. Appropriate clothing and shields
4. Access to a safe workshop area
5. Examples of dirty and broken agricultural equipment
6. Examples of several types and sizes of electrodes
7. Pocket-sized electrode guide
8. Electric grinding wheel and safety equipment
9. Cleaning equipment and solutions

Student Performance Objective 3:

Given a metal to be welded and the appropriate welding equipment, the student will follow safe operating procedures to prevent injury to himself/herself, other workers or damage to the equipment as determined by the instructor or a person he/she designates.

Instructional Areas:

1. Identifying the hazards common to welding and the safety procedures associated with each

   a. Preventing electrical shock

      (1) Using proper electrical connections
      (2) Checking and repairing or replacing cables and connections
      (3) Wearing appropriate gloves
      (4) Avoiding wet floors or ground

   b. Preventing burns

      (1) Protecting face and eyes with appropriate welding equipment
      (2) Wearing proper clothing
      (3) Wearing proper gloves
      (4) Twisting stuck electrode free before removing shield
      (5) Using pliers to hold hot electrodes

   c. Protecting from radiant energy

      (1) Wearing welding equipment in protecting eyes before striking arc
      (2) Checking head and face shields for cracked or broken lens
      (3) Treating eyes with recommended solutions when need

   d. Protecting from gases and fumes

      (1) Ventilating shop properly when welding
      (2) Observing special precautions when welding metals containing zinc
      (3) Utilizing forced ventilation when welding in confined areas
      (4) Drinking sweet milk to overcome nausea resulting from welding where zinc oxide fumes are present

   e. Using care around combustible materials

      (1) Cleaning shop area frequently
      (2) Covering containers of flammable materials or removing from area before welding
      (3) Using special precautions and/or procedures when welding containers that have contained combustible materials

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Before beginning welding, the instructor may have two students inspect the clothing of fellow students and explain whether the clothing is appropriate for welding.

2. Given a face shield used in welding shops, the instructor may have several students demonstrate the use of the shield.

Examples of Evaluation Techniques:

1. While arc welding, the student should be able to demonstrate at least three ways to prevent burns.

2. Given the task of replacing lens in a face shield, the student should be able to replace lens in a face shield without damaging the shield or breaking the lens.

Instructional Resources:

1. Access to welding shop
2. Face shield and extra lens
3. Appropriate clothing for welding
4. Cleaning equipment for sweeping
5. Examples of ventilation equipment
6. Pliers

Student Performance Objective 4:

Given metals to be welded and the appropriate welding equipment, the student will prepare the metal and perform butt and fillet welds in the following positions in sufficient strength for the required operating conditions and to the satisfaction of the instructor or a person he/she designates:

- a. Flat position
- b. Horizontal position
- c. Vertical position
- d. Overhead position

Instructional Areas:

1. Performing butt and fillet welds while welding in the flat position
    - a. Preparing the metal for welding
    - b. Placing the metal on a flat surface
    - c. Selecting the proper electrode
    - d. Selecting and adjusting the proper amperage setting
    - e. Striking the arc
    - f. Moving the electrode at the correct angle when welding
    - g. Welding the metals
2. Performing butt and fillet welds while in the horizontal position
    - a. Preparing the metal for welding
    - b. Clamping the metal in an upright position
    - c. Selecting the proper electrode
    - d. Selecting and adjusting the proper amperage setting
    - e. Starting from bottom, striking the arc
    - f. Moving the electrode at the correct angle when welding
    - g. Welding with one bead above the other
    - h. Cooling the metal after each two electrodes
3. Performing butt and fillet welds while welding in the vertical position
    - a. Welding in the vertical-down position
        - (1) Preparing the metal for welding
        - (2) Securing the metal in a vertical position
        - (3) Selecting the proper electrode
        - (4) Selecting and adjusting the proper amperage setting
        - (5) Starting weld at upper corner, welding downward
        - (6) Moving the electrode at the correct angle when welding
        - (7) Welding the metals with a short arc for deep penetration
    - b. Welding in the vertical-up position
        - (1) Preparing the metal for welding
        - (2) Securing the metal in a vertical position
        - (3) Selecting the proper electrode

        (4) Selecting and adjusting the proper amperage
        (5) Starting the weld at the bottom of the metal
        (6) Moving the electrode at the correct angle when welding
        (7) Holding a long arc momentarily to heat the metal, welding the metal

4. Performing butt and fillet welds while welding in overhead position

    a. Preparing the metal for welding
    b. Securing the metal in an overhead position
    c. Selecting the proper electrode
    d. Selecting and adjusting the proper amperage setting
    e. Striking and holding a long arc to preheat metal
    f. Moving the electrode at the correct angle when welding
    g. Welding the metal

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. The instructor may have students clean and clamp a piece of metal in an upright position in preparation for doing a horizontal butt weld.

2. Given a piece of broken agricultural equipment in the field, the instructor and students may visit the equipment and three students may prepare the surface for welding and perform the necessary weld to repair the equipment.

Examples of Evaluation Techniques:

1. Given the task of welding mild steel, the student should be able to select the appropriate electrode from a selection of electrodes according to manufacturer's specifications.

2. Given appropriate welding equipment and electrodes, the student should be able to make a butt weld in a flat position on ½ inch mild steel to the satisfaction of the instructor.

Instructional Resources:

1. Access to a welding workshop area
2. Arc welding machine and accessories
3. A selection of electrodes
4. Access to a piece of agricultural equipment under field conditions that requires welding
5. Different types of metal of varying thickness for students to weld
6. Chart showing classification and use of various electrodes

Student Performance Objective 5:

Given various operations to perform with the welder, the student will prepare the metal and perform the following operations to the satisfaction of the instructor or a person he/she designates:

- a. Weld cast iron
- b. Cut and groove
- c. Hardsurface
- d. Use carbon arc torch

Instructional Areas:

1. Welding cast iron

    - a. Selecting the appropriate electrodes
    - b. Preheating and cooling
    - c. Cleaning and preparing casting
    - d. Selecting proper heat
    - e. Controlling heat in the casting
    - f. Finishing the weld

2. Cutting and grooving

    - a. Selecting the appropriate electrode
    - b. Selecting proper amperage setting
    - c. Performing the following operations:

        - (1) Cutting
        - (2) Piercing
        - (3) Gouging
        - (4) Beveling

3. Hardsurfacing

    - a. Selecting the appropriate electrode
    - b. Cleaning area to be hardsurfaced
    - c. Using manufacturer's recommendation for size and type of electrode and amperage setting

   d. Securing sample materials and trial welding
   e. Welding with thin even layers of material in flat beads
   f. Removing all slag before adding additional layers

4. Using the carbon arc torch

   a. Connecting torch cables to welder
   b. Selecting the appropriate amperage setting
   c. Starting the arc
   d. Performing carbon arc welding

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a piece of cast iron to be welded, the instructor may ask a student to select the proper amperage for welding that particular piece of cast iron.

2. Given a piece of ½ inch mild steel, and an arc welding machine, the instructor may ask a student to demonstrate the piercing of the metal with an electrode.

3. Given a chart on electrodes, the instructor may ask several students to select an electrode for hardsurfacing a plowshare used in sandy soil.

4. Given a carbon-arc torch and new carbons, the instructor may ask two students to replace the carbons with the new carbons.

Examples of Evaluation Techniques:

1. Given access to an arc welder and the task of welding cast iron, the student should be able to select an appropriate electrode for welding cast iron and set the amperage as recommended by the manufacturer of the electrode.

2. The student should be able to cut ½ inch metal with an arc welder and cutting-electrode to the satisfaction of the instructor.

3. The student should be able to select the appropriate electrode size for hardsurfacing a plowshare according to manufacturer's specifications.

4. Given a carbon-arc torch and new carbons, the student should be able to replace the carbons so that the carbons are 3/16 inch apart.

Instructional Resources:

1. Samples of cast iron to be welded
2. Welding equipment and accessories
3. ¼ inch mild steel pieces to be welded
4. An electrode chart
5. Carbon-arc torch and new carbons
6. A selection of electrodes

SERVICING AND REPAIRING ELECTRICAL SYSTEMS IN FARM TRACTORS

CODE--01.0301

Module Concept: The electrical system is important to the starting, lighting and accessories on a tractor. The Agricultural Equipment Mechanic needs to know the functions and components of the tractor electrical system.

The writers of this module have included instructional areas which should be taught by the instructor so that the student will be capable of servicing and repairing tractor electrical systems.

Prerequisites: Admission to the Agricultural Equipment Mechanics Program is sufficient evidence of qualification for entry into the course.

Module Goal: When this module of instruction is completed, the student will be able to service and repair tractor electrical systems.

Student Performance Objective 1: When provided equipment used to diagnose defects in the electrical system of farm tractors and given a tractor with malfunctions in the starting circuit, lighting and accessory circuits, the student will select and use the equipment in diagnosing the malfunctions in the electrical system, by following approved trouble-shooting procedures detailed in appropriate service manual.

Instructional Areas:

1. Determining the functions of the following components of the tractor electrical system:
    a. Generator
    b. Voltage regulator
    c. Starter
    d. Solenoid
    e. Bendix
    f. Switches
    g. Fuses
    h. Breakers
    i. Ammeter
    j. Coil
    k. Alternator
    l. Distributor
    m. Spark plugs
    n. Power cable
    o. Battery
2. Identifying and using equipment to diagnose defects in a farm tractor electrical system.

   a. Hydrometer
   b. Thermometer
   c. Voltmeter
   d. Timing light
   e. Feeler gauge
   f. Spark plug gap gauge
   g. Condenser tester

Examples of Supporting References:

1. Fundamentals of Machine Operation-Preventive Maintenance. John Deere Service Publications. Moline, Illinois. 1973.

2. The Tractor Electrical System. American Association of Vocational Instructional Materials. Engineering Center. Athens, Georgia. Current edition.

3. Tractor Maintenance, Principles and Procedures. American Association of Vocational Instructional Materials. Engineering Center. Athens, Georgia. 1970.

Examples of Student Learning Activities:

1. Given a battery and hydrometer, the instructor may ask several students to test the strength of the battery with the hydrometer.

2. Given a farm tractor electrical system with a short in the wiring, the instructor may ask two students to use the voltmeter to search for and determine the source of the short.

Examples of Evaluation Techniques:

1. Given a tractor electrical system, the student should be able to identify and demonstrate the function of the fuses.

2. Given a tractor electrical system, the student should be able to adjust the generator belt tension to the specification of the given manual.

Instructional Resources:

1. Access to a farm tractor electrical system
2. Access to equipment for diagnosing defects in electrical systems:

   a. Hydrometer
   b. Thermometer
   c. Voltmeter
   d. Timing light

e. Feeler gauge
f. Spark plug gap gauge
g. Condenser tester

Student Performance Objective 2:

When provided equipment used to repair the defects in the electrical system of farm tractors with defects in the charging circuit, the student will select and use the equipment to remove, disassemble, test, inspect, replace, reassemble and install the following parts in the charging circuit:

a. Generator
b. Voltage Regulator
c. Alternator (If the engine is so equipped)

according to the procedures in appropriate service manual

Instructional Areas:

1. Removing the generator
    a. Testing the generator output with generator regulator tester for amperage, voltage and resistance
2. Disassembling the generator
    a. Checking and replacing the brushes
3. Installing the generator
4. Polarizing the generator
5. Adjusting the generator belt tension
6. Removing the voltage regulator
    a. Cleaning the contact points
    b. Replacing the voltage regulator
7. Removing the alternator
    a. Replacing the alternator

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a generator in a tractor, the instructor may have several students adjust the generator belt tension.

2. Given a voltage regulator, the instructor may have two students remove the regulator and clean the contact points.

Examples of Evaluation Techniques:

1. Using a generator, the student should be able to polarize the generator by following the procedures given in the service manual.

2. Given an alternator, the student should be able to remove and replace the alternator.

Instructional Resources:

1. Access to an operational charging circuit
2. Tools for working on a charging circuit
3. New generator brushes
4. Extra regulator and alternator

Student Performance Objective 3:

When provided equipment used to repair defects in the electrical system of farm tractors and given a farm tractor with malfunctions in the starting circuit, the student will select and use the equipment to remove, disassemble, inspect, test, replace, reassemble, and install the following parts in the starting circuit:

a. Starting motor
b. Starting switch
c. External solenoid

according to the procedures in appropriate service manual

Instructional Areas:

1. Inspecting and servicing the starting circuit

    a. Removing the starter from the engine

        (1) Inspecting and cleaning the drive mechanism
        (2) Replacing the brushes
        (3) Replacing the external solenoid
        (4) Conducting a no-load test on the starter
        (5) Installing the starter

    b. Inspecting the ignition switch and replacing
    c. Inspecting and testing the battery

        (1) Adding water to a battery
        (2) Cleaning cables and terminals
        (3) Testing a battery
        (4) Charging a battery

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a starter in a tractor engine, the instructor may have several students remove the starter from the engine and replace the brushes.

2. Given a tractor battery, the instructor may have two students check the water level in the battery.

Examples of Evaluation Techniques:

1. Given a starter, the students should be able to inspect and replace the brushes in the starter by following the procedures in service manual.

Instructional Resources:

1. Access to a tractor with an operational starting circuit
2. New brushes
3. Extra external solenoid
4. Equipment for cleaning a battery
5. Battery water
6. Tools for working on the starting circuit
7. Hydrometer
8. Battery charger

Student Performance Objective 4:

When provided equipment used to repair defects in the electrical systems of farm tractors and given a farm tractor with malfunctions in the lighting and/or accessory circuit, the student will select and use the equipment to remove, inspect, service and install the following parts in the lighting and/or accessory circuits:

a. Switches
b. Fuses
c. Wires
d. Gauges

according to the procedures in appropriate service manual.

Instructional Areas:

1. Testing circuits for shorts, grounds and open circuits

2. Replacing fuses or circuit breakers

3. Replacing switches in the circuits

4. Replacing defective gauges

5. Replacing damaged electrical wires
6. Testing and replacing light bulbs

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a tractor electrical system and fuses, the instructor may ask several students to replace an electrical fuse.
2. Given a piece of damaged electrical wire in a tractor electrical system, the instructor may ask two students to replace the wire.

Examples of Evaluation Techniques:

1. Given an electrical system that is operational except for a broken wire, the student should be able to locate and repair/replace the wire in such a way that the system is operational.
2. Given a light bulb, the student should be able to test the light bulb with complete accuracy.

Instructional Resources:

1. Access to a tractor electrical system lighting and accessory circuit
2. Fuses
3. Gauges normally found on tractors
4. Electrical wire
5. Light bulbs for a tractor electrical system
6. Tools for repairing a tractor lighting and accessory circuit

SERVICING AND REPAIRING IGNITION SYSTEMS IN FARM TRACTORS

CODE--01.0301

Module Concept: The ignition system is important to the starting and smooth operation of a farm tractor. The Agricultural Equipment Mechanic needs to know the functions and components of the tractor ignition system.

The writers of this module have included instructional areas which should be taught by the instructor so that the student will be capable of servicing and repairing tractor ignition systems.

Prerequisites: Admission to the Agricultural Equipment Mechanics program is sufficient evidence of qualification for entry into the course.

Module Goal: When this module of instruction is completed, the student will be able to service and repair tractor ignition systems.

Student Performance Objective 1: Given access to a farm tractor with malfunctions in the ignition system and equipment used for checking defects in the system, the student will select and use the equipment in diagnosing the nature of the malfunctions by following the approved troubleshooting procedures detailed in appropriate service manual.

Instructional Areas:

1. Identifying the components of a tractor ignition system:
   - a. Spark plugs
   - b. Ignition wires
   - c. Distributor
   - d. Coil
   - e. Points and condenser
   - f. Battery
2. Identifying the symptoms caused by defects and maladjustments in the tractor ignition system:
   - a. Lack of power
   - b. Overheating
   - c. Misfiring
   - d. Difficulty in starting
3. Identifying troubleshooting procedures for a tractor ignition system:
   - a. Using a timing light
   - b. Using a spark plug gap gauge
   - c. Inspecting ignition wires

d. Inspecting the battery

    (1) Visual inspection
    (2) Using a hydrometer to check battery specific gravity

e. Determining if spark plugs are firing
f. Inspecting and testing spark plug wires
g. Inspecting the cap and rotor
h. Inspecting breaker points, condenser and breaker cam
i. Testing coil for electrical current
j. Using a voltmeter

Examples of Supporting References:

1. Fundamentals of Machine Operation-Preventive Maintenance. Moline, Illinois. John Deere Service Publications. 1973.

2. The Tractor Electrical System. American Association of Instructional Materials. Engineering Center. Athens, Georgia.

3. Tractor Maintenance, Principles and Procedure. American Association for Vocational Instructional Materials. Engineering Center. Athens, Georgia. 1970.

Examples of Student Learning Activities:

1. Given a tractor ignition system, the instructor may have several students turn the engine crankshaft until the distributor cam opens the breaker points to their widest position.

2. Given a spark plug, spark plug gauge, and a spark plug chart, the instructor may have several students check the spark plug gap and determine if it is correct.

Examples of Evaluation Techniques:

1. Given a spark plug gauge and a spark plug the student should be able to adjust the spark plug with complete accuracy according to manufacturer's specifications.

2. Given a battery, the student should be able to use a hydrometer to determine the specific gravity to within 95% accuracy.

Instructional Resources:

1. Access to an operational tractor ignition system
2. Timing light
3. Feeler gauge
4. Spark plug gap gauge
5. Condenser tester
6. Hydrometer
7. Timing light
8. Voltmeter

Student Performance Objective 2:

Given access to a farm tractor with malfunctions in the ignition system and equipment used for eliminating malfunctions in the system, the student should be able to select and use the appropriate equipment to remove, inspect, and test the following components of the system:

a. Spark plugs
b. Ignition wires
c. Distributor
d. Coil
e. Points and condenser
f. Battery

according to directions in appropriate service manual.

Instructional Areas:

1. Removing spark plugs

    a. Pulling wire from plug
    b. Loosening spark plug with deep-well socket
    c. Cleaning area around plug
    d. Removing plugs

        (1) Placing in order to match cylinders from which each came

2. Inspecting spark plugs

    a. Checking for fouled or eroded conditions
    b. Testing to see if firing

3. Removing spark plug wires

    a. Checking to see if spark is coming through
    b. Checking metal connectors

4. Removing and inspecting distributor and points

    a. Cleaning outside of distributor housing and cap
    b. Removing cap and wiping interior clean
    c. Inspecting distributor caps for chips or cracks
    d. Removing the rotor
    e. Removing and checking seal of dust cover
    f. Checking centrifugal advance mechanism

    g. Inspecting contact surfaces of breaker points

5. Removing the coil

    a. Determining if an electrical current is coming from coil
    b. Removing and testing the coil

6. Removing and inspecting condenser

    a. Testing condenser with condenser tester
    b. Using instructions with tester unit

7. Removing and testing battery

    a. Removing ground cable
    b. Removing other battery cable
    c. Wiping off cables with cloth

        (1) Dipping cables into baking soda and water mixture

    d. Inspecting battery for damage

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a tractor ignition system with spark plugs and a deep-well socket, the instructor may have several students remove a spark plug.

2. Given a condenser and condenser tester, the instructor may ask several students to test the condenser.

Examples of Evaluation Techniques:

1. Given a tractor ignition with spark plugs the student should be able to remove the spark plugs in such a way that they can be correctly installed in the cylinders from which each was taken.

2. Given a distributor the student should be able to use a feeler gauge to check the point gap correctly.

Instructional Resources:

1. Access to an operational tractor ignition system
2. Tools to disassemble the tractor ignition system
3. Condenser tester
4. Cloths
5. Baking soda

Student Performance OBjective 3:

Given access to a farm tractor with identified problems in the ignition circuit and the equipment used for eliminating the problems, the student should be able to select and use the appropriate equipment to replace or service, install and adjust when necessary the following components of the ignition system:

- a. Spark plugs
- b. Ignition wires
- c. Distributor
- d. Coil
- e. Points and Condenser
- f. Battery

according to directions and speci[illegible]ons in appropriate service manual.

Instructional Areas:

1. Servicing spark plugs
    - a. Cleaning oily plugs with cleaning solvent
    - b. Cleaning threads with wire hand brush
    - c. Cleaning the plug
        - (1) Bending ground electrode
        - (2) Filing both electrodes
        - (3) Bending ground back to original position
        - (4) Cleaning metal filings from plug
        - (5) Checking the gap and cap as necessary
2. Installing spark plugs
    - a. Installing and tighten with fingers
    - b. Tightening plug with spark plug socket and torque wrench
3. Installing new spark plug wires
    - a. Cutting plug wire
    - b. Installing connectors
    - c. Installing new wires in proper order
        - (1) Checking polarity
4. Servicing the distributor
    - a. Replacing the points and condenser
        - (1) Removing breaker arm and spring
        - (2) Cleaning and lubricating the cam
        - (3) Removing the condenser
        - (4) Installing new condenser and breaker points in reverse order

        (5) Adjusting breaker points

    b. Installing rotor and distributor cap
    c. Timing the distributor

5. Replacing the coil

    a. Installing a coil

6. Servicing the battery

    a. Scrubbing corrosion from terminal posts
    b. Removing dirt and corrosion from top of battery
    c. Brushing mixture of baking soda and water on top of battery and posts
    d. Flushing off residue with clean water
    e. Drying battery with clean cloth
    f. Installing battery
    g. Attaching non-grounded cable to opposite terminal
    h. Attaching ground cable to opposite termina-
    i. Applying coating of light grease to terminals and clamps
    j. Examining breather holes in top of each battery cap to be sure they are open
    k. Using a charger-tester to recharge a battery

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a spark plug and file, the instructor may have several students file both electrodes of the spark plug.

2. Given a feeler gauge and a distributor the instructor may have several students check and adjust the breaker points gap.

Examples of Evaluation Techniques:

1. Given spark plug wire and connectors, the student should be able to cut the wires to the appropriate length and install the connectors in such a way that the new spark plug wires operate properly.

2. Given a battery and a battery charger-tester, the student should be able to charge the battery by following the recommendations of the charger-tester manufacturer.

Instructional Resources:

1. Access to an operational tractor ignition system
2. Battery charger-tester
3. Spark plug

4. Feeler gap gauge
5. Cleaning solvent
6. Cloths
7. Soda and appropriate bucket
8. File for filing spark plug
9. Spark plug socket and torque wrench
10. Spark plug wire
11. Wire cutter
12. Spark plug connectors

SERVICING AND REPAIRING GASOLINE FUEL SYSTEMS ON FARM TRACTORS

CODE--01.0301

Module Concept: The gasoline fuel system supplies a combustible mixture of gasoline and air to the tractor engine for power. The Agricultural Equipment Mechanic needs to know the components and functions of the tractor gasoline fuel systems.

The writers of the module have included instructional areas which should be taught by the instructor so that the student will be capable of servicing and repairing tractor ignition systems.

Prerequisites: Admission to the Agricultural Equipment Mechanics Program is sufficient evidence of qualification for entry into the course.

Module Goal: When this module of instruction is completed, the student will be able to service and repair tractor gasoline fuel systems.

Student Performance Objective 1: Given access to a farm tractor which uses gasoline fuel with observable symptoms in the fuel system and equipment used to diagnose the symptoms in the system, the student will select and use the equipment in diagnosing the nature of the malfunctions in the fuel system by following appropriate troubleshooting procedures as detailed in appropriate service manual.

Instructional Areas:

1. Identifying the components of the tractor gasoline fuel system and their functions:

   a. Fuel tank
   b. Fuel lines
   c. Air cleaner
   d. Fuel filter and sediment bowl
   e. Carburetor
   f. Fuel pump

2. Identifying symptoms and problems caused by defects and maladjustments in the farm tractor gasoline fuel system:

   a. Lack of power
   b. Engine misfiring
   c. Excessive use of fuel
   d. Difficulty in starting
   e. Engine running irregularly and surging

3. Identifying troubleshooting procedures used for the gasoline fuel system

   a. Inspecting fuel tank for leaks
   b. Inspecting for leaks along the line and at

various connections

c. Inspecting sediment bowl

Examples of Supporting References:

1. Tractor Maintenance: Principles and Procedures. Athens, Georgia: Engineering Center, American Association of Vocational Instructional Materials. 1970.

2. Fundamentals of Machine Operation-Preventive Maintenance. Moline, Illinois: John Deere Service Publication. 1973

Examples of Student Learning Activities:

1. Given a farm tractor gasoline fuel system, the instructor may have several students identify the fuel pump and diagram its function in the gasoline fuel system.

2. Given a farm tractor with a gasoline fuel system which is using excessive fuel, the instructor may ask several students to demonstrate the trouble-shooting procedures recommended to identify the cause of excessive fuel consumption.

Examples of Evaluation Techniques:

1. Given a gasoline fuel system, the student should be able to identify at least five of the six major components by their common names.

2. Given a tractor gasoline fuel system, the student should be able to inspect the system in such a way as to identify all locations of gasoline leaks in the system.

Instructional Resources:

1. Access to an operational tractor gasoline fuel system
2. Diagram of gasoline fuel system

Student Performance Objective 2:

Given access to a farm tractor which uses gasoline fuel with defects in the fuel system and equipment used to disassemble the system, the student will select and use the equipment to remove, disassemble and inspect the following components of the gasoline fuel system:

a. Fuel tank
b. Fuel lines
c. Air cleaner

   d. Fuel filter
   e. Carburetor
   f. Fuel pump

by following procedures in appropriate service manual

Instructional Areas:

1. Removing and disassembling the fuel tank

   a. Removing fuel from tank
   b. Removing bolts and straps wich appropriate tools
   c. Taking tank off
   d. Unscrewing float mechanism
   e. Inspecting fuel tank

2. Removing fuel lines

   a. Shutting off fuel supply line
   b. Selecting appropriate tools
   c. Loosening fuel lines
   d. Taking fuel lines off
   e. Inspecting fuel lines

3. Disassembling dry type air cleaner

   a. Squeezing dust unloader
   b. Removing hood or grille when necessary
   c. Wiping off dust around end of cleaner
   d. Loosen hand screw or clamp
   e. Removing clamp
   f. Removing filter from element
   g. checking condition of rubber gasket on end of filter element

4. Disassembling the oil-bath air cleaner

   a. Removing oil cup and screen tray
   b. Inspecting center tube and lower filter element

5. Disassembling fuel filter

   a. Closing valves on fuel supply line
   b. Loosening nut that holds sediment bowl in place
   c. Removing bowl, screen and gasket
   d. Inspecting screen for debris
   e. Opening fuel valve and observing flow of fuel

6. Disassembling and inspecting the carburetor

   a. Removing the carburetor
   b. Disassembling the carburetor

      (1) Visually inspecting the various parts
      (2) Measuring float adjustment
      (3) Checking for carburetor warpage

   c. Checking the strainer screen in the carburetor
   d. Checking for air leaks at the manifold connections

7. Disassembling the fuel pump

   a. Removing the fuel pump
   b. Inspecting fuel pump

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given appropriate tools and a farm tractor carburetor, the instructor may have several students disassemble the carburetor.

2. Given a sediment bowl, the instructor may have two students disassemble the bowl and inspect the strainer screen.

Examples of Evaluation Techniques:

1. Given the task of servicing a carburetor the student should be able to disassemble a carburetor and measure the float adjustment with complete accuracy.

2. Given the task of cleaning a fuel filter the student should be able to close the valve on the fuel supply line in such a way that the fuel flow is completely stopped.

Instructional Resources:

1. Access to an operational tractor gasoline fuel system.
2. Appropriate tools to disassemble the system
3. Cloths for cleaning out dust

Student Performance Objective 3:

Given access to a farm tractor which uses gasoline fuel with defects in the system and equipment used to repair the fuel system, the student should be able to use the appropriate equipment to replace, reassemble, install and adjust the following components to the gasoline fuel system:

   a. Fuel tank
   b. Fuel lines
   c. Air cleaner
   d. Fuel filter
   e. Carburetor
   f. Fuel pump

according to manufacturer's specifications.

Instructional Areas:

1. Repairing and installing fuel tank
    - a. Observing safety practices to follow in repairing fuel tank
    - b. Soldering or otherwise repairing fuel tank
    - c. Installing fuel tank
        - (1) Fastening tank on to tractor
        - (2) Filling tank and checking for leaks
2. Installing fuel lines
    - a. Replacing fuel line connections by hand
    - b. Tightening connections on fuel lines with wrench
3. Servicing, reassembling and installing dry type air cleaners
    - a. Cleaning area around element and cleaning dust cap and baffle
    - b. Tapping filter gently to loosen dirt
        - (1) Rotating element during tapping and shaking out dust
    - c. Directing air from air nozzle inside filter element
        - (1) Blowing and rotating until clean
    - d. Cleaning by washing when appropriate
        - (1) Cleaning away dust with clean water from a hose
        - (2) Washing element in warm water and detergent
        - (3) Rinsing the element
        - (4) Drying the element
    - e. Installing air cleaner
        - (1) Replacing filter element in cleaner
        - (2) Tightening wing nut holding element in place
4. Servicing, reassembling and installing oil-bath air cleaner
    - a. Removing dirt from center tube
    - b. Cleaning dirt from lower filter
    - c. Cleaning shell and upper metal-wool filter
    - d. Draining filter body and screen for several minutes
    - e. Cleaning screened air intake cap or precleaner
    - f. Checking hose connections

  g. Reassembling filter parts

5. Servicing and reassembling fuel filter

  a. Washing strainer in cleaning solvent
  b. Cleaning sediment bowl
  c. Reassembling sediment bowl, strainer, filter and gasket
  d. Tightening the bowl against the gasket
  e. Opening the fuel valve
  f. Starting engine and checking for leaks

6. Servicing, reassembling and installing carburetor

  a. Installing carburetor repair kit
  b. Reassembling the carburetor
  c. Making initial carburetor adjustments
  d. Installing the carburetor

7. Adjusting the gasoline carburetor

  a. Adjusting the idling speed

    (1) Starting the engine and allowing to warm up to operating temperature
    (2) Setting the speed-control lever completely closed
    (3) Turning idle speed adjusting screw clockwise to decrease speed, adjusting to idling speed as per operator's manual

  b. Adjusting idling fuel-air mixture

    (1) Starting engine and allowing to warm to operating temperature
    (2) Setting speed control lever in idling position
    (3) Turning idle-mixture adjusting screw clockwise until engine begins to shake
    (4) Turning idle-mixture adjusting screw counterclockwise until the engine begins to run smoothly
    (5) Rechecking idle speed

  c. Adjusting load fuel-air mixture

    (1) Running engine at full throttle
    (2) Turning the full-load adjusting screw clockwise until engine begins to loose power
    (3) Turning the full-load adjusting screw counterclockwise until the engine gives off black smoke from the exhaust
    (4) Turning the full-load adjusting screw clockwise until the engine runs smoothly
    (5) Checking adjustment by accelerating while under load

8. Installing the gasoline fuel pump

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a gasoline fuel system and a tachometer, the student may have several students connect the tachometer to the engine and turn the idle speed adjusting screw to demonstrate affect of idling adjustment to RPM's

2. Given access to compressed air and a dry-type air cleaner, the instructor may have two students demonstrate to the class the procedure for cleaning the filter element.

Examples of Evaluation Techniques:

1. Given a gasoline tank with a leak in it, the student should be able to select the necessary equipment and follow safety procedures for repairing the leak in such a way that the leak is completely stopped.

2. Given a tractor fuel system the student should be able to adjust the idle-mixture screw until the engine begins to shake.

Instructional Resources:

1. Access to an operational tractor with gasoline fuel system
2. Tools for reassembling and adjusting the fuel system
3. Container of cleaning solvent (not gasoline)
4. Carburetor repair kit
5. Access to compressed air
6. Tachometer
7. Soldering equipment for repairing gasoline tanks
8. Cloths
9. Operator's manual for the tractor

SERVICING AND REPAIRING THE CLUTCH ASSEMBLY IN FARM TRACTORS

CODE--01.0301

Module Concept:

The clutch in a farm tractor provides the method of disconnecting the engine from its load while the tractor is being started, shifted or during idling. The Agricultural Equipment Mechanic must be able to repair and adjust the clutch assembly for the smooth operation of the farm tractor.

The purpose of this module is to depict for the instructor areas which should be taught relative to clutch assembly servicing and repair and enable the student to effectively perform service and repair on farm tractor clutch assemblies.

Prerequisities:

The following modules should be studied before this module is undertaken:

1. Using Safety and Sanitation Practices in Agricultural Equipment Mechanic Shops
2. Selecting, Using and Caring for Tools and Equipment Used in Agricultural Equipment Mechanic Shops

Module Goal:

At the completion of this module, the student will be able to service and repair farm tractor clutch assemblies.

Student Performance Objective 1:

Given access to a farm tractor with defects in the clutch assembly and equipment used for checking defects in the system, the student will select and use the appropriate equipment in diagnosing the nature of the defects by following the appropriate troubleshooting procedures as detailed in appropriate service manual.

Instructional Areas:

1. Identifying the components of the clutch assembly:
    a. Clutch disk
    b. Pressure plate
    c. Pilot bearing and release bearing
    d. Clutch springs
    e. Flywheel
    f. Clutch shaft
2. Troubleshooting clutch defects from symptoms:
    a. Slipping clutch
    b. Grabbing or chattering clutch
    c. Squeaking clutch
    d. Rattling or vibrating clutch

Examples of Supporting References:

1. Fundamentals of Machine Operation: Preventive Maintenance. Moline, Illinois: John Deere and Company. 1973.

Examples of Student Learning Activities:

1. Given a model of a clutch assembly, the instructor may ask several students to point out the clutch plate.

2. Given a clutch assembly on a farm tractor, the instructor may ask several students to start the tractor and demonstrate the proper use of the clutch in the changing of gears in the tractor.

Examples of Evaluation Techniques:

1. Given a tractor service manual and a farm tractor with an operational clutch assembly, the student should be able to measure the clutch pedal free travel and determine from the manual with accuracy, if the amount of free pedal travel is correct for the assembly.

2. Given a model clutch assembly, the student should be able to demonstrate to the class what happens to the gears in the clutch assembly when it is engaged, by following instructions of appropriate manufacturer's manual.

Instructional Resources:

1. Model of clutch assembly
2. Access to tractor with operational clutch assembly
3. Tractor service manual
4. Chart of standard dry disk clutch engaged and disengaged
5. Ruler

Student Performance Objective 2:

Given access to a farm tractor with clutch assembly that has an incorrect amount of free pedal travel, and equipment for adjusting the clutch assembly, the student will select and use the equipment to adjust the clutch linkage and lubricate the clutch release bearing by following procedures in appropriate service manual.

Instructional Areas:

1. Checking operator's manual for recommended free travel distance

2. Checking clutch pedal free travel measurement

   a. Measuring distance depressed before resistance noticed

    b. Proceeding when measurement is different from specifications

3. Locating pedal adjusting mechanism

4. Adjusting linkage

    a. Loosening adjusting screw
    b. Adjusting linkage
    c. Lightening adjusting screw

5. Rechecking clutch pedal free travel distance to determine if correct

6. Lubricating clutch release bearing

    a. If sealed bearing, follow manufacturer's recommendations
    b. If it is to be lubricated:

        (1) Locating grease fitting
        (2) Wiping grease clean from fitting
        (3) Applying grease with grease gun
        (4) Wiping grease from fitting

Examples of Supporting References:

In addition to supporting references listed in Student Performance Objective 1, the following may also be helpful:

1. Tractor Maintenance: Principles and Procedures. Athens, Georgia: Engineering Center, American Association for Vocational Instructional Materials. 1970.

Examples of Student Learning Activities:

1. Given access to a tractor with clutch assembly and a ruler, the instructor may ask several students to measure the amount of clutch pedal free travel

2. Given access to a tractor with clutch assembly, the instructor may ask two students to locate the means provided for clutch adjustment.

Examples of Evaluation Techniques:

1. Given the task of adjusting the clutch free pedal travel on a given tractor, the student should be able to select the appropriate tools to make the adjustments.

2. Given a tractor with a clutch assembly and a ruler, the student should be able to measure the clutch pedal free travel with 90% accuracy.

Instructional Resources:

1. Screwdriver
2. Adjustable pliers
3. Ruler
4. Set of wrenches
5. Service manual for given tractor

Student Performance Objective 3:

Given access to a farm tractor with defects in the clutch assembly and equipment used to repair the system, the student should be able to select and use the equipment to remove, disassemble, inspect, repair and reassemble and install the following components of the clutch assembly:

a. Clutch disk
b. Pressure plate
c. Pilot bearing and release bearing
d. Clutch springs
e. Clutch shaft
f. Flywheel

according to manufacturer's directions and specifications.

Instructional Areas:

1. Separating the tractor in such a way to open up the clutch assembly
2. Removing the clutch assembly
3. Inspecting the components of the clutch assembly

    a. Checking flywheel friction driving surface
    b. Checking pilot bearing

        (1) Removing and replacing bearing and thrust washer

    c. Inspecting release bearing assembly

        (1) Replacing the necessary parts

    d. Inspecting clutch plate for warpage
    e. Inspecting the clutch disks
    f. Inpsecting springs for corrosion, pitting or distortion
    g. Inspecting the spline for wear

4. Reassembling the clutch pack
5. Adjusting spring tension
6. Installing clutch pack in clutch assembly housing

    a. Adjusting release lever

7. Rejoining the tractor

Examples of Supporting References:

In addition to supporting references listed in Student Performance Objectives 1 and 2, service manual for the equipment being worked on will be necessary.

Examples of Student Learning Activities:

1. Given a farm tractor with clutch assembly and the equipment to disassemble the clutch assembly, the instructor may ask several students to separate the tractor to get at the clutch assembly.
2. Given a disassembled clutch pack, the student should be able to adjust the spring tension to the specifications of the given service manual.

Examples of Evaluation Techniques:

1. Given a farm tractor clutch assembly, the student should be able to remove and replace a bearing and thrust washer by following manufacturer's recommendations.
2. Given a farm tractor clutch assembly, the student should be able to disassemble the assembly in such a way that the clutch plate may be inspected.

Instructional Resources:

1. Tractor supports and jacks
2. Blocking materials
3. Appropriate set of tools for given tractor
4. Access to tractor with operational clutch assembly
5. Examples of defective clutch assembly components
6. Clutch aligning tool
7. Appropriate grease and grease gun

SERVICING AND REPAIRING THE DIFFERENTIAL AND FINAL DRIVE ASSEMBLY IN FARM TRACTORS

CODE--01.0301

Module Concept: The differential assembly transmits power to the drive axles and allows each drive wheel to rotate at a different speed and still propel its own load. The final drive assembly gives the final reduction in speed and increase in torque to the drive wheels. By reducing speeds, the final drive lowers the stress and simplifies the transmission.

Servicing and repairing the differential and final drive assembly are essential for long trouble-free operation of the farm tractor.

The purpose of this module is to indicate to the instructor areas which should be taught to enable the student to effectively perform service and repair of farm tractor differential and final drive assemblies.

Prerequisites: The following modules should be studied before this module is undertaken:

1. Using Safety and Sanitation Practices in Agricultural Equipment Mechanic Shops
2. Selecting, Using and Caring for Tools and Equipment Used in Agricultural Equipment Mechanic Shops

Module Goal: At the completion of this module, the student will be able to service and repair the differential and final drive assemblies on farm tractors.

Student Performance Objective 1: Given access to a farm tractor with symptoms that indicate malfunctions in the differential and/or final drive assembly and equipment used for checking defects in the two systems, the student will select and use the equipment in diagnosing the nature of the malfunctions in the differential and final drive assembly by following the procedures described in appropriate service manual.

Instructional Areas:

1. Identifying the components of the differential and their principles of operation
    a. Bevel gear and axle
    b. Bevel pinions
    c. Ring gear
    d. Pinion gear
    e. Thrust washers
2. Identifying the components of the final drive assembly

3. Troubleshooting differential and final drive assembly systems from the following:
    a. Noisy
    b. Turning difficulty
    c. Mechanical lock doesn't hold
    d. Hydraulic lock doesn't hold
    e. Loss of oil
    f. Overheating

Examples of Supporting References:

1. Fundamentals of Machine Operation: Preventive Maintenance. Moline, Illinois: John Deere and Company. 1973.
2. Tractor Maintenance: Principles and Procedures. Athens, Georgia: Engineering Center, American Association for Vocational Instructional Materials. 1970.

Examples of Student Learning Activities:

1. Given a tractor with an operational differential and/or final drive assembly, the instructor may ask several students to observe the operation of the equipment and list the defects they have observed.
2. Given several charts depicting differing assemblies of the differential and final drives, the instructor may ask several students to identify the differential and final drive assemblies in each chart.

Examples of Evaluation Techniques:

1. Given a farm tractor differential which is noisy, the student should be able to diagnose the cause of the noisy sound according to the given tractor troubleshooting chart.
2. Given a chart showing a tractor transmission, differential and final drive, the student should be able to identify the three separate units.

Instructional Resources:

1. Access to a farm tractor with differential and final drive assemblies
2. Charts showing different arrangements of differential and final drive assemblies
3. Troubleshooting chart

Student Performance Objective 2:

Given access to a farm tractor with differential and final drive assembly, and equipment to service the two systems, the student will select and use the equipment in performing general servicing requirements (e.g. checking and adding oil, flushing rear axle housing) by following procedures in appropriate service manual.

Instructional Areas:

1. Checking oil levels with dipstick
    a. Locating the dipstick
    b. Removing the dipstick
    c. Wiping off the dipstick with clean cloth
    d. Reinserting the dipstick completely
    e. Pulling out the dipstick and reading the oil level

2. Checking oil from an oil level plug
    a. Locating the oil level plug
    b. Inserting finger to determine oil level

3. Adding oil to differential and final drive assemblies
    a. Determining the recommended oil of proper viscosity
    b. Locating oil filler plug or filler cap
    c. Adding appropriate quantity of oil

4. Draining and refilling differential, final drive and/or rear axle housing
    a. Driving tractor until oil is well heated
    b. Parking tractor on a level surface
    c. Removing drain plugs and catching used oil in a container
        (1) Using a metal shield where necessary
    d. Flushing the housing
    e. Replacing transmission oil filter where necessary
    f. Cleaning dirt and grease from filler plug and surrounding areas
    g. Replacing plugs
    h. Removing filler cap and refilling with proper amount and type of oil
    i. Cleaning filler cap and breather where appropriate
    j. Replacing filler cap

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given access to a farm tractor with differential, the instructor may ask two students to locate the safe mark or full level on the transmission or differential dipstick.
2. Given access to a filler cap from a farm tractor differential or transmission, the instructor may ask two students to select the appropriate solvent and clean the filler cap.

Examples of Evaluation Techniques:

1. Given a farm tractor with final drive to be drained, the student should be able to select the appropriate tools and drain the oil from the drive in such a way that no oil is spilled on the tractor tire.
2. Given a farm tractor with an oil level plug in the differential or final drive, the student should be able to remove the plug and determine with 90% accuracy the amount of oil to be added to bring the oil up to the proper level.

Instructional Resources:

1. Access to an operational tractor differential and final drive system
2. Operator's manual for given tractor
3. Clean cloths
4. Metal shield
5. Appropriate tools for removing filler and drain plugs
6. Cleaning solvent
7. Clean oil to be added to given tractor
8. Used oil container
9. New transmission oil filler where appropriate

Student Performance Objective 3:

Given access to a farm tractor with defects in the final drive assembly and equipment used for eliminating the problems, the student will select and use the equipment to remove, disassemble, inspect, replace, reassemble, install and adjust the components in the differential according to instructions in appropriate repair manual.

Instructional Areas:

1. Disassembling differential
    a. Opening differential housing

   b. Removing differential pinion retaining rings
   c. Pulling differential pinion pins and pinion gears
   d. Removing nuts and bolts securing gears
   e. Removing differential gears from the housing

2. Inspecting and replacing differential components

   a. Checking for gear wear
   b. Checking for pitted or scored bearings
   c. Checking for damaged oil seals
   d. Checking for cracked or broken parts
   e. Replacing parts

3. Reassembling and installing differential components

   a. Installing differential pinions in spider
   b. Installing differential pins
   c. Securing pins in place with retaining rings
   d. Cleaning edges of gears
   e. Oiling bolt threads and installing bolts and nuts
   f. Tightening nuts evenly to specified torque
   g. Installing unit into housing

4. Adjusting the components in the differential

   a. Adjusting pre-load bearings
   b. Checking gear backlash

Examples of Supporting References:

Service manual for the equipment being worked on will be necessary.

Examples of Student Learning Activities:

1. Given used gears taken from differentials, the instructor may ask two students to identify the type of locking device, if any, that is used.

Examples of Evaluation Techniques:

1. Given a tractor differential to be reassembled, the student should be able to adjust the gear backlash according to manufacturer's specifications.

2. Given bolts to be installed in the differential, the student should be able to tighten the bolts to the required torque with 90% accuracy.

Instructional Resources:

1. Access to a tractor differential that can be disassembled and reassembled
2. Appropriate tools for assembling and reassembling the given tractor differential
3. A selection of used and worn differential gears

4. Given tractor manual
5. Blocking materials

Student Performance Objective 4:

Given access to a farm tractor with defects in the final drive assembly and the equipment used for eliminating the problems, the student will use the equipment to remove, disassemble, inspect, replace, reassemble, install and adjust the components in the final drive assembly according to instructions in appropriate repair manual.

Instructional Areas:

1. Disassembling the final drive
    a. Opening final drive housing
    b. Removing various components of the final drive
2. Inspecting and replacing differential components
    a. Checking for gear wear
    b. Checking for pitting or scored bearings
    c. Checking for damaged oil seals
    d. Checking for cracked or broken parts
    e. Replacing parts
3. Reassembling and installing differential components
    a. Installing pinions, pins and/or bolts
    b. Cleaning edges of gears
    c. Tightening nuts evenly to specified torque
    d. Installing final drive unit into housing
4. Adjusting the components in the final drive
    a. Adjusting preload bearings
    b. Checking gear backlash

Examples of Supporting References:

1. Service manual for the equipment being worked on is essential.
2. Reading the Micrometer. Clemson, South Carolina: Media Center, Clemson University. 1970

Examples of Student Learning Activities:

1. Given access to a farm tractor with a final drive assembly and the tools to disassemble the drive, the instructor may have several students demonstrate the use of the dial indicator to measure amount of backlash.

2. Given a final drive assembly, the instructor may have two students drain the housing in preparation for removing the final drive components.

Examples of Evaluation Techniques:

1. Given a final drive assembly from a farm tractor, the student should be able to measure the thickness of the shim pack halves with a micrometer within .004.
2. Given a farm tractor final drive assembly and tools to disassemble the system, the student should be able to install pinions where required by following manufacturer's specifications.

Instructional Resources:

1. Access to a farm tractor with final drive assembly
2. Given service manual for farm tractor
3. Appropriate tools for disassembly and reassembly of the final drive assembly
4. Container for used oil
5. Micrometer
6. Dial indicator
7. Blocking material

SERVICING AND REPAIRING THE COOLING SYSTEM IN FARM TRACTORS

CODE--01.0301

Module Concept:

The tractor cooling system prevents the engine from overheating, and burning up the engine parts. The cooling system also regulates the temperature to keep the engine at the best level of operation.

The Agricultural Equipment Mechanic needs to know the operation and service requirements of the tractor cooling system so that he/she can keep it operating at its optimum level of efficiency.

The writers of this module have included instructional areas which should be taught by the instructor so that the student will be capable of servicing and repairing tractor cooling systems.

Prerequisites:

Admission to the Agricultural Equipment Mechanics Program is sufficient evidence of qualification for entry into the course.

Module Goal:

When this module of instruction is completed, the student will be able to service and repair tractor cooling system.

Student Performance Objective 1:

Given access to a farm tractor with defects in the cooling system and equipment used to diagnose the defects in the system, the student will select and use the equipment to diagnose the nature of the defects in the cooling system by following procedures described in appropriate service manual.

Instructional Areas:

1. Identifying the components of a tractor cooling system and explaining their functions.

   a. Radiator and pressure cap
   b. Fan and fan belt
   c. Coolant pump
   d. Engine coolant jacket
   e. Thermostat
   f. Connecting hoses
   g. Coolant

2. Identifying symptoms caused by defects and maladjustments in the water cooling system:

   a. Pre-ignition
   b. Detonation
   c. Engine knock
   d. Engine wear
   e. Poor fuel economy

3. Identifying causes of symptoms
    a. Engine running too hot
    b. Engine running too cold
4. Checking and adding coolant to appropriate level

Examples of Supporting References:

1. Fundamentals of Machine Operation-Preventive Maintenance. John Deere Service Publications. Moline, Illinois. 1973
2. Tractor Maintenance, Principles and Procedures. American Association of Vocational Instructional Materials. Engineering Center. Athens, Georgia. 1970.
3. The Operation, Care and Repair of Farm Machinery. Deere and Company. Moline, Illinois. Current edition.

Examples of Student Learning Activities:

1. Given burned spark plugs, the instructor may ask two students to report to the class the possible cause from a defect in the cooling system.
2. Given a tractor cooling system, the instructor may ask three students to remove and replace a radiator hose.

Examples of Evaluation Techniques:

1. Given a tractor cooling system, the student should be able to test and adjust the fan belt for proper deflection according to specifications in the operator's manual.
2. Given a tractor cooling system, the student should be able to check the level of coolant in the system and fill it in such a way that the coolant level is at the manufacturer's recommended level.

Instructional Resources:

1. Access to an operational tractor cooling system that the students can work on
2. Charts of a cooling system
3. Burned and fouled spark plugs
4. Coolant

5. Fan belts, pressure caps, coolant pumps, radiator hoses, and thermostats showing defects

6. Gaskets, clamps and seals for a tractor cooling system

Student Performance Objective 2:

Given access to a farm tractor with defects in the cooling system and equipment used to diagnose the defects in the system, the student should be able to select and use the equipment to clean and service the cooling system by following directions in appropriate service manual and labels on the coolant containers used.

Instructional Areas:

1. Cleaning the cooling system and checking the coolant level

    a. Checking coolant level
    b. Draining, cleaning and flushing the system

2. Selecting and adding coolant

    a. Using charts to determine the amount of various coolants for winter protection
    b. Adding the appropriate coolant

3. Using inhibitors

    a. Determining the appropriate inhibitor
    b. Adding the inhibitor

4. Lubricating the coolant pump

    a. Determining the lubricant
    b. Lubricating the pump with the appropriate lubricant

5. Testing the cooling system

    a. Inspecting visually for leaks

6. Determining the use of grille screens

7. Following appropriate winter storage procedures

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a freezing protection table, the instructor may have two students report to the class on their recommendations for winter protection in Lower Michigan.

2. The instructor may ask two students to visit a tractor supply and service center and note the various inhibitors available for use in tractor cooling systems and report to the class their findings.

Examples of Evaluation Techniques:

1. Given a tractor cooling system, the student should be able to add coolant for the appropriate winter protection according to the specifications of the operator's manual.

2. Given a coclant pump and lubricants, the student should be able to lubricate the pump according to specifications of the operator's manual.

Instructional Resources:

1. Access to an operational tractor cooling system that the students can work on
2. Freezing protection tables
3. Labels of various coolants
4. Examples of various rust inhibitors
5. Appropriate coolant
6. Tools to service the tractor cooling system
7. Lubricants and lubricating equipment for use on the coolant pump

Student Performance Objective 3:

Given access to a farm tractor with identified defects in the cooling system and equipment used to repair the defects in the system, the student will select and use the equipment to remove, disassemble, inspect, and test the following parts of the cooling system:

a. Fan belt and fan
b. Radiator hoses
c. Thermostat
d. Radiator
e. Water pump
f. Water filter

According to procedures in appropriate service manual

Instructional Areas:

1. Inspecting the fan and fan belt

   a. Checking fan belt for fraying
   b. Checking for loose fan belts
   c. Checking for damaged fan

2. Inspecting the radiator hoses

   a. Checking the outside surfaces for defects
   b. Removing hoses and checking interior surfaces

3. Inspecting the thermostat

   a. Removing the thermostat and inspecting for breaks and corrosion
   b. Testing thermostat for opening and closing

4. Inspecting the radiator

   a. Inspecting the radiator for leaks
   b. Checking the coolant using a hydrometer
   c. Removing the radiator
   d. Installing and using a pressure tester
   e. Inspecting the radiator cap

5. Inspecting the water pump

   a. Checking the water pump for leaks
   b. Removing the water pump

6. Inspecting the water filter

   a. Draining the sediment from the filter
   b. Removing the filter element

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a farm tractor cooling system, the instructor may ask two students to inspect the water filter by draining the filter of any sediment.

2. Given an hydrometer, the instructor may ask several students to test the coolant for freezing protection level.

Examples of Evaluation Techniques:

1. Given a farm tractor cooling system, the student should be able to remove the thermostat and test it for opening and closing to the satisfaction of the instructor.

2. Given a farm tractor cooling system, the student should be able to use a hydrometer to test the freezing protection level with 95% accuracy.

Instructional Resources:

1. Access to an operational tractor cooling system
2. Tools for disassembling the cooling system components
3. Radiator pressure tester
4. Hydrometer

Student Performance Objective 4:

Given access to a farm tractor with identified defects in the cooling system and equipment to repair the defects in the system, the student should be able to select and use the equipment to replace, reassemble, install and adjust the following parts of the cooling system:

a. Fan belt and fan
b. Radiator hoses
c. Thermostat
d. Radiator
e. Water pump
f. Water filter

by following the procedures in appropriate service manual.

Instructional Areas:

1. Repairing the fan belt and fan

    a. Replacing a damaged fan
    b. Replacing a damaged or worn fan belt

2. Replacing radiator hoses

    a. Installing damaged radiator hoses

3. Replacing the thermostat

4. Repairing the radiator

    a. Straightening bent radiator fins
    b. Removing debris from radiator
    c. Stopping temporary leaking

        (1) Using stop-leak compounds

    d. Soldering the leaking area
    e. Replacing the radiator

5. Replacing the water pump
    a. Installing the water pump
6. Repairing water filter
    a. Installing a new filter element

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a tractor cooling system, the instructor may ask several students to install a new thermostat
2. Given at least three radiator hoses in various conditions of wear the instructor may ask several students to determine which hoses are useable and which should be thrown away.

Examples of Evaluation Techniques:

1. Given a minor leak in a radiator and stop-leak compound to stop the leak temporarily, the student should be able to use the stop-leak compound by carefully following manufacturer's directions.
2. Given a farm tractor cooling system and the appropriate water pump, the student should be able to remove the old water pump and install a new one by following manufacturer's directions.

Instructional Resources:

1. Access to an operational farm tractor cooling system
2. Spare fan belts, thermostats, water pumps, and water filter elements
3. Stop-leak compound
4. Tools for reassembling the farm tractor cooling system
5. Soldering equipment and appropriate solder

SERVICING AND REPAIRING LP-GAS FUEL SYSTEMS ON FARM TRACTORS

CODE--01.0301

Module Concept:

The LP-Gas fuel system supplies a combustible mixture of LP-Gas and air to the tractor engine for power. The Agricultural Equipment Mechanic needs to know the components and functions of the tractor LP-Gas fuel system.

The writers of this module have included instructional areas which should be taught by the instructor so that the student will be capable of servicing and repairing the tractor LP-Gas fuel system.

Prerequisites:

Admission to the Agricultural Equipment Mechanics Program is sufficient evidence of qualification for entry into the course.

Module Goal:

When this module of instruction is completed, the student will be able to service and repair tractor LP-Gas fuel systems.

Student Performance Objective 1:

Given access to a farm tractor which uses LP-Gas fuel and given equipment and materials for testing for leaks in the system, the student will select and use the equipment and materials in testing the LP-Gas fuel system for leaks by following the procedures described in appropriate service manual.

Instructional Areas:

1. Testing the LP-Gas fuel system
   - a. Mixing a solution of warm soapy water
   - b. Using a clean paint brush, apply the warm soapy water solution at all points in the LP-Gas system where leaks could occur
   - c. Watch the area of application of soapy water for bubbles

Examples of Supporting References:

1. Handling and Using Gasoline and Liquified Petroleum Gas Safely. VAS 3013, Urbana, Illinois: Vocational Agricultural Service, University of Illinois.

Examples of Student Learning Activities:

1. Given an operational LP-Gas fuel system, the instructor may ask two students to mix a solution of warm soapy water.

2. Given an operational LP-Gas fuel system, the instructor may ask several students to point out the areas where leaks may occur in the system.

Examples of Evaluation Techniques:

1. Given a LP-Gas system, the student should be able to point out at least three places where leaks in the system may occur.

2. Given a selection of paint brushes, the student should be able to determine the appropriate brush to test the LP-Gas system to the satisfaction of the instructor.

Instructional Resources:

1. Access to an operational LP-Gas fuel system
2. Warm water
3. Mild detergent
4. Selection of paint brushes, to include dirty brushes and brushes which are very stiff

Student Performance Objective 2:

Given access to a farm tractor which uses LP-Gas and with defects in the fuel system, and equipment used to diagnose the symptoms in the system, the student will select and use the equipment for diagnosing the defects in the LP-Gas fuel system by following appropriate troubleshooting procedures as detailed in appropriate service manual.

Instructional Areas:

1. Identifying components of the LP-Gas fuel system

    a. Fuel strainer
    b. Air cleaner
    c. Carburetor
    d. Regulator
    e. Pressurized fuel tank

2. Identifying symptoms caused by defects

    a. Loss of power
    b. Difficulty in starting
    c. Excessive fuel use
    d. Rough idling

3. Following general troubleshooting procedures

    a. Turning on vapor valve when engine will not start

b. Cleaning strainer when engine lacks power
c. Checking for leaks when LP-Gas is found in radiator
d. Adjusting and/or cleaning carburetor when
    (1) Engine starts but does not run properly
    (2) Engine backfiring
    (3) Lack of power
    (4) Engine using too much fuel

Examples of Supporting References:

In addition to references in Student Performance Objective 1, the following may be helpful:

1. Fundamentals of Machine Operation - Preventive Maintenance. Moline: Illinois, Deere and Company. 1973.

2. Tractor Maintenance - Principles and Procedures. Athens, Georgia: American Association for Vocational Instructional Materials. 1970.

Examples of Student Learning Activities:

1. Given a LP-Gas fuel system, the instructor may ask several students to turn on the vapor valve of the system.

2. Given a LP-Gas fuel system, troubleshooting chart, the instructor may ask several students to use the chart in identifying symptoms caused by defects in the fuel system.

Examples of Evaluation Techniques:

1. Given a LP-Gas fuel system on which the instructor has turned off the vapor valve, the student should be able to identify the problem in such a way that the problem is corrected and the tractor started.

2. Given a LP-Gas fuel system, the student should be able to clean and replace the fuel strainer according to manufacturer's specifications.

Instructional Resources:

1. Access to operational LP-Gas fuel system
2. Troubleshooting chart on LP-Gas tractors
3. Set of appropriate wrenches
4. Container of solvent (not gasoline)
5. Clean, lint-free rags

Student Performance Objective 3:

Given access to a farm tractor which uses LP-Gas fuel and possible defects in the fuel system, with equipment used to remove and disassemble the system, the student will select and use the equipment to remove, disassemble, and inspect the following components of the system:

a. Fuel strainer or filter
b. Air cleaner
c. Carburetor
d. Regulator
e. Tank

by following procedures in appropriate service manual.

Instructional Areas:

1. Cleaning the LP-Gas fuel strainer

    a. Closing liquid and vapor valves at fuel tank
    b. Removing the drain plug from the strainer
    c. Loosening nut holding filter bowl in place
    d. Removing the bowl, gasket and filter element
    e. Washing the filter in solvent
    f. Cleaning sediment bowl and wiping dry

2. Removing air cleaner

    See module on Gasoline Fuel Systems

3. Removing carburetor

    a. Loosening nuts
    b. Taking carburetor off the system
    c. Disassembling carburetor

4. Removing regulator

    a. Observing precautions in removing regulator
    b. Loosening nuts
    c. Removing regulator
    d. Disassembling regulator

5. Removing LP-Gas fuel tank

    a. Observing rules, regulations and precautions in emptying fuel tank
    b. Loosening nuts
    c. Disconnecting fuel lines
    d. Removing the tank

Examples of Supporting References:

Supporting references were listed in Student Performance Objectives 1 and 2.

Examples of Student Learning Activities:

1. Given a LP-Gas fuel system, the instructor may ask several students to loosen the drain plug in the fuel strainer bowl slowly to relieve pressure build up.
2. Given a LP-Gas fuel system, the instructor may ask two students to consult the local LP-Gas distributor and report to the class on the approved method of emptying the LP-Gas fuel tank.

Examples of Evaluation Techniques:

1. Given a LP-Gas fuel system on the farm tractor, the student should be able to blow the accumulation of moisture and sediment from the strainer bowl in such a way that the sediment bowl is properly blown out without damage to the equipment or person.
2. The student should be able to accurately identify the cause of frosting on the filter or fuel line.

Instructional Resources:

1. Access to operational LP-Gas fuel system on a farm tractor
2. Set of appropriate wrenches
3. Container of solvent
4. Clean, lint-free rags
5. Source of air pressure

Student Performance Objective 4:

Given access to a farm tractor which uses LP-Gas fuel with identified defects in the fuel system, and with equipment used to repair the system, the student should be able to select and use the equipment to reassemble, replace, install and adjust the following components of the system:

a. Fuel strainer or filter
b. Air cleaner
c. Carburetor
d. Regulator
e. Tank

by following the manufacturer's directions and specifications.

Instructional Areas:

1. Replacing the fuel strainer or filter
   - a. Replacing disposable filter
   - b. Replacing other parts as necessary
   - c. Installing gasket, filter and sediment bowl
   - d. Tightening nuts or bolts to secure filter in place
   - e. Opening the fuel supply valves at tank and checking for leaks

2. Replacing air cleaner

   See module on Gasoline Fuel Systems

3. Replacing the carburetor in LP-Gas fuel systems
   - a. Installing replacement parts as needed
   - b. Assembling the carburetor
   - c. Making initial adjustments
   - d. Installing carburetor on the LP-Gas fuel system
   - e. Checking for leaks with soapy water
   - f. Making final adjustments

4. Replacing the regulator in LP-Gas fuel systems
   - a. Adjusting the regulator
   - b. Assembling the regulator
   - c. Installing the regulator
   - d. Checking the regulator for leaks
     - (1) Turning ignition on
     - (2) Opening vapor withdrawal valve
     - (3) Removing radiator cap
     - (4) Checking coolant for bubbles

5. Replacing the LP-Gas fuel tank
   - a. Replacing the valves
   - b. Installing the tank
   - c. Tightening all connections
   - d. Adding fuel
   - e. Checking for leaks

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1 and 2.

Examples of Student Learning Activities:

1. Given an operational LP-Gas fuel system with a disposable fuel filter system, the instructor may ask two students to change the disposable filter.

2. Given a carburetor repair kit and access to an operational LP-Gas fuel system, the instructor may ask several students to install the replacement parts.

Examples of Evaluation Techniques:

1. Given a LP-Gas fuel system on a farm tractor, the student should be able to check the coolant for bubbles by following the approved manufacturer's procedures for checking for leaks in the regulator.

2. Given a LP-Gas fuel system on a farm tractor, the student should be able to add fuel to the fuel tank by following all safety precautions.

Instructional Resources:

1. Set of appropriate wrenches
2. Container of solvent
3. New gaskets
4. New disposable fuel filter
5. Clean, lint-free rags
6. Replacement parts for LP-Gas fuel system carburetor
7. New valves for LP-Gas fuel tank
8. LP-Gas fuel
9. Access to an operational LP-Gas fuel operated tractor
10. Soapy water
11. Replacement parts for LP-Gas fuel strainer
12. Replacement parts for air cleaner

SERVICING AND REPAIRING DIESEL FUEL SYSTEMS ON FARM TRACTORS

CODE--01.0301

Module Concept:

The diesel fuel system supplies a combustible mixture of diesel fuel and air to the tractor engine for power. The Agricultural Equipment Mechanic needs to know the components and functions of the tractor system.

The writers of this module have included instructional areas which should be taught by the instructor so that the student will be capable of servicing and repairing tractor diesel fuel systems.

Prerequisities:

Admission to the Agricultural Equipment Mechanics Program is sufficient evidence of qualification for entry into the course.

Module Goal:

When this module of instruction is completed, the student will be able to service and repair tractor diesel fuel systems.

Student Performance Objective 1:

Given access to a farm tractor which uses diesel fuel with defects or problems in the diesel fuel system, and equipment used for checking the problems in the system, the student will select and use the equipment in diagnosing the nature of the malfunctions in the system by following appropriate troubleshooting procedures as detailed in appropriate service manual.

Instructional Areas:

1. Identifying the components of the tractor diesel fuel system and their functions:
   a. Fuel tank
   b. Fuel pump
   c. Fuel filter
   d. Fuel lines
   e. Injection pump
   f. Injection nozzles
   g. Air cleaner
2. Identifying symptoms and problems caused by defects and maladjustments in the farm tractor diesel fuel system:
   a. Difficulty in starting
   b. Rough idling
   c. Engine knock
   d. Lack of power

3. Identifying troubleshooting procedures used for the diesel fuel system
    a. Checking for air in fuel system
    b. Having service shop check:
        (1) Injection pump
        (2) Repairing nozzles
        (3) Timing injection pump
    c. Checking fuel tank cap
    d. Checking filters

Examples of Supporting References:

1. Tractor Maintenance: Principles and Procedures. Athens, Georgia: Engineering Center, American Association of Vocational Instructional Materials. 1970.

2. Fundamentals of Machine Operation - Preventive Maintenance. Moline, Illinois: John Deere Service Publication. 1973.

Examples of Student Learning Activities:

1. Given a diagram of diesel fuel systems, the instructor may ask several students to point out on the diagram the critical areas where even small particles of dirt can seriously damage the system.

2. Given an operational diesel fuel system on a farm tractor, the instructor may ask a student to check the fuel tank cap to see if the vent is plugged.

Examples of Evaluation Techniques:

1. Given a farm tractor with a diesel fuel system, the student should be able to list at least three defects in the fuel system that could cause the tractor to lose power.

2. Given a farm tractor with a diesel fuel system, the student should be able to demonstrate how to daily remove sediment and water from the system.

Instructional Resources:

1. Access to an operational diesel fuel system
2. Diagram of a diesel fuel system
3. Diesel fuel system troubleshooting chart

Student Performance Objective 2:

Given access to a farm tractor which uses diesel fuel with air in the fuel system, and the equipment used for bleeding the system, the student will select and use the equipment in diagnosing the nature of the malfunctions in the system by following the procedures outlined in appropriate service manual.

Instructional Areas:

1. Opening bleed plug or plugs on top of filters, starting with filter closest to fuel tank first
2. Opening fuel supply valve
   a. Pushing hand primer several strokes
3. Closing bleed plug after all air is removed
4. Loosening one half of injection nuts only one turn
5. Cranking the engine with starter until fuel flows without foam
6. Tightening line connectors until free of leaks
7. Starting engine and running until smooth

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a diesel fuel system and the tools used to bleed the system, the instructor may ask two students to use two wrenches to demonstrate how to loosen an injection nut.
2. Given a diesel fuel system, the instructor may ask two students to point out the location of the pushing hand primer, if the engine has one.

Examples of Evaluation Techniques:

1. Given a diesel fuel system on a farm tractor, the student should be able to relieve the pressure in the fuel system in such a way that all the pressure is safely relieved.

2. Given a farm tractor with a diesel fuel system, the student should be able to open the bleed plugs on the top of the filters by following the procedures in the service manual.

Instructional Resources:

1. Access to a farm tractor with an operational diesel fuel system
2. Tools appropriate for bleeding the system

Student Performance Objective 3:

When provided a farm tractor which uses diesel fuel with defects or problems in the fuel system, and the equipment used for making repairs, the student will select and use the equipment to remove, disassemble, and inspect the following components of the diesel fuel system:

- a. Fuel tank
- b. Fuel pump
- c. Fuel filter
- d. Fuel lines
- e. Injection pump
- f. Injection nozzles
- g. Air cleaner

according to directions in appropriate service manual.

Instructional Areas:

1. Removing and disassembling the fuel tank
    - a. Removing fuel from the fuel tank
    - b. Removing bolts and straps
    - c. Lifting tank off
    - d. Unscrewing float mechanism
    - e. Inspecting the fuel tank
2. Removing fuel pump
    - a. Loosening bolts
    - b. Lifting off fuel pump
    - c. Inspecting the sediment bowl by removing bowl, screen and gasket and cleaning screen or filter
3. Disassembling the fuel filter
    - a. Turning off shut-off valve
        - (1) Cleaning outside of filter and surrounding area

   b. Draining fuel from filter if provision is provided
   c. Removing filter or filter bowl
   d. Cleaning filter if not disposable
   e. Inspecting for ruptures or damage

4. Removing the fuel lines

   a. Shutting off fuel supply
   b. Selecting appropriate tools
   c. Loosening fuel lines
   d. Removing fuel lines
   e. Inspecting fuel lines

5. Removing the fuel injection pump

   a. Shutting off fuel supply
   b. Loosening bolts with appropriate tools
   c. Removing fuel injection pump

6. Removing injector nozzles

   a. Loosening connections and disconnecting fuel lines
   b. Removing fuel lines from injection nozzles
   c. Removing injector nozzles

7. Disassembling dry-type air cleaners

   a. Squeezing dust unloader
   b. Removing hood or grille when necessary
   c. Wiping off dust around end of cleaner
   d. Loosening hand screw or clamp
   e. Removing clamp
   f. Removing filter from element
   g. Checking condition of rubber gasket

8. Disassembling the oil-bath air cleaner

   a. Removing oil cup and screen tray
   b. Inspecting center tube and lower filter element

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a diesel fuel system, the instructor may ask several students to inspect the sediment bowl on the fuel pump and explain why careful service is necessary on diesel fuel systems.

2. Given a diesel fuel system, the instructor may ask two students to remove and inspect one injection nozzle for damage.

Examples of Evaluation Techniques:

1. Given a diesel fuel system, the student should be able to remove the fuel pump by following the procedures in given service manual.

2. Given a diagram of a diesel fuel system, the student should be able to point out two places where dirt or water can enter the system.

Instructional Resources:

1. Access to an operational diesel fuel system
2. Appropriate tools for disassembling the system
3. Clean, lint free rags
4. Container of cleaning solvent (not gasoline)
5. Container to catch waste fuel
6. Small, soft bristle scrub brush
7. Replaceable filters

Student Performance Objective 4:

Given access to a farm tractor which uses diesel fuel with defects in the fuel system and the equipment used for repairing the system, the student will select and use the equipment to replace, repair, reassemble, install and adjust the following components of the diesel fuel system:

- a. Fuel tank
- b. Fuel pump
- c. Fuel filter
- d. Fuel lines
- e. Injection pump
- f. Injection nozzles
- g. Air cleaner

according to the instructions in appropriate service manual.

Instructional Areas:

1. Repairing and installing fuel tank

    a. Observing safety practices in repairing fuel tanks
    b. Soldering fuel tank
    c. Installing fuel tank

        (1) Fastening tank on tractor
        (2) Filling tank and checking for leaks

2. Installing fuel pumps

   a. Tightening bolts and connections with fingers
   b. Tightening bolts and connections with appropriate wrench

3. Repairing and installing fuel filters

   a. Cleaning inside of filter bowl or body
   b. Installing cleaned filter or new disposable filter

      (1) Installing new gaskets

   c. Securing filter to filter body
   d. Replacing or cleaning second stage filter if necessary
   e. Replacing drain plug or tightening drain valve
   f. Opening fuel shut-off valve
   g. Bleeding the fuel filters

      (1) Opening bleed plug or plugs on top of filter
      (2) Opening fuel supply valve
      (3) Pushing primer several strokes where appropriate
      (4) Closing bleed plug after all air is removed

4. Installing injection pumps

   a. Tightening bolts
   b. Attaching fuel line connections
   c. Turning on fuel supply
   d. Locating the timing marks and timing the pump

5. Installing injection nozzles

   a. Testing spray pattern and popping pressure
   b. Tightening nozzles into engine block
   c. Connecting fuel lines

6. Installing dry type air cleaners

   a. Cleaning around element and cleaning dust cap and baffle
   b. Tapping filter gently to loosen dirt

      (1) Rotating element during tapping and shaking out dust

   c. Directing air from air nozzle inside filter element

      (1) Blowing air and rotating until clean

   d. Cleaning by washing when appropriate

    - (1) Cleaning away dirt with clean water from a hose
    - (2) Washing element in warm water and detergent
    - (3) Rinsing the element
    - (4) Drying the element

  - e. Installing the air cleaner
    - (1) Replacing filter element in cleaner
    - (2) Tightening wing nut holding element in place

7. Installing oil-bath air cleaner
   - a. Removing dirt from center tube
   - b. Cleaning dirt from lower filter
   - c. Cleaning shell and upper metal-wood filter
   - d. Draining filter body and screen for several minutes
   - e. Cleaning screened air intake cap or precleaner
   - f. Checking hose conditions
   - g. Reassembling filter parts

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a water hose with running water and a dry type air cleaner, the instructor may ask two students to demonstrate the method of cleaning the filter with running water.
2. Given a diesel fuel system with injection nozzles, the instructor may ask several students to test the spray pattern of one nozzle.

Examples of Evaluation Techniques:

1. Given a diesel fuel system with injection pumps, the student should be able to locate the timing marks and positively identify them.
2. Given a diesel fuel system, the student should be able to open the bleed plug on top of the filter in such a way that all the air is removed from the filter.

Instructional Resources:

1. Clean, lint-free rags
2. Container of cleaning solvent (not gasoline)
3. Container to catch waste fuel
4. Set of appropriate wrenches
5. Small, soft bristle scrub brush
6. Replaceable filters, as needed

SERVICING AND REPAIRING TRANSMISSIONS IN FARM TRACTORS

CODE--01.0301

Module Concept:

Tractor transmissions are used as a means of mechanically achieving the following functions:

a. Transmitting power from the engine to the driven member (e.g. drive wheels, power take-off, power lift, etc.) of the tractor

b. Increasing or decreasing speed or power of the tractor

c. Controlling forward or reverse traveling of the tractor

Servicing and repairing tractor transmissions as recommended by manufacturers will lengthen the life of this important component of the tractor. Problems such as difficulty in shifting, transmission noise, slipping out of gear, and oil leakages are prevented if the proper servicing and repairing of transmissions is performed according to manufacturer's directions.

Prerequisites:

Admission in the Agricultural Equipment Mechanics Program is sufficient evidence of qualification for entry into this course.

Module Goal:

When this module is completed, the student should be able to service, diagnose the nature of defects and repair various types of tractor transmissions.

Student Performance Objective 1:

Given access to a farm tractor with defects in the transmission system and equipment used to diagnose, the student will select and use the appropriate equipment to diagnose the nature of the defects according to approved troubleshooting procedures in given service manual.

Instructional Areas:

1. Identifying types of tractor transmissions
    a. Sliding gear transmissions
    b. Planetary gearing
2. Identifying the components of tractor transmissions
    a. Gears
    b. Bearings
    c. Shaft
    d. Synchronizer

- (1) Blocking rings
- (2) Lock rings
- (3) Gear or hub
- (4) Synchronizer sleeve
- (5) Shifter Plates

e. Carrier
f. Ring gear

3. Understanding the operating principles of tractor transmissions

   a. Identifying operation of sliding gear transmissions

      (1) Low gear
      (2) Reverse
      (3) Intermediate gear
      (4) High gear
      (5) Neutral

   b. Identifying operations of planetary transmissions

      (1) Applying power to the carrier
      (2) Delivering power from the carrier
      (3) Stopping rotation of carrier

4. Performing general transmission troubleshooting procedures

   a. Checking for transmission oil level and for broken and worn gears on noisy transmissions
   b. Checking clutch free pedal and linkage when transmission is hard to shift or sticks in gears
   c. Checking transmission oil level when clutch slips
   d. Checking gaskets and drain plug when transmission oil leaks
   e. Checking clutch, control linkage and oil filter when machine won't move
   f. Checking shift control when transmission shifts erratically
   g. Checking oil level and filter when there is low system pressure
   h. Checking oil level, oil filter and core in oil cooler when transmission is overheating

Examples of Supporting References:

1. Tractor Transmissions. Athens, Georgia. American Association for Agricultural Engineering and Vocational Agriculture. Current Edition.

2. Henderson G.E. and J. Howard Turner. Revised by W. Harold Parady. Tractor Maintenance-Principles and Procedures. Athens, Georgia. American Association for Vocational Instructional Materials. 1970.
3. Brown, Arlen D., Farm Tractor Maintenance, 3rd Edition. Danville, Illinois: The Interstate Printers and Publishers. 1968
4. Farm Tractors, FT-53S. 910 S. Michigan Avenue, Chicago, Illinois: American Oil Company.
5. Fore, J.M., Tractor Operation and Daily Care. Athens, Georgia: American Association for Agricultural Engineers and Vocational Agriculture. 1967. pp. 51-54.

Examples of Student Learning Activities:

1. Given the opportunity to visit at least two farm tractor dealerships, the instructor may ask several students to identify the models and types of tractor transmissions observed.
2. The instructor may ask several students to prepare a chart showing the different makes of tractors and the models and types of transmissions available in each.
3. The instructor may ask several students to prepare a chart of a transmission and label the various components.
4. The instructor may have several students read an operator's manual on the operation and care of a tractor transmission and report to the class.

Examples of Evaluation Techniques:

1. The student should be able to label at least 4 components of a tractor transmission on a diagram of a transmission.
2. The student should be able to demonstrate on a model sliding gear transmission the operation of first gear to the satisfaction of the instructor.

Instructional Resources:

1. Operator's manual
2. Charts
3. Books on tractor transmissions
4. Slides
5. An actual or a model of a tractor transmission
6. Appropriate tools for troubleshooting
7. Troubleshooting chart

Student Performance Objective 2:

Given access to a farm tractor transmission system and access to tools and equipment, the student will select and use the equipment to perform the following tasks on the transmission system of a farm tractor:

- a. Remove the system
- b. Disassemble the system
- c. Inspect the system
- d. Reassemble the system
- e. Replace parts
- f. Install the system
- g. Make adjustments

by following procedures in appropriate service manual.

Instructional Areas:

1. Operating the transmission system
   - a. Draining fuels
   - b. Removing transmission top
   - c. Separating the tractor
2. Using sanitation practices when working with the transmission system.
3. Inspecting conditions in the tractor transmission
   - a. Wearing of teeth
   - b. Scoring, pitting, rolling and peening of gears
   - c. Broken parts
   - d. Wearing of bearings and shafts
4. Replacing broken parts
   - a. Removing and replacing defective shafts and gears
   - b. Replacing transmission oil seals
   - c. Replacing bearings and pre-loading bearings
   - d. Removing and replacing latches, shift levers, pivots and thrust washers

   - e. Using dial indicator to check end play on transmission
   - f. Checking for backlash

5. Rejoining the tractor

6. Adjusting the tractor transmission

   a. Adjusting the clutch release bearing

      (1) Locating pedal adjusting mechanism
      (2) Adjusting the linkage

   b. Adding or removing shims under front bearing housing

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given access to a variety of used transmissions, the instructor may ask several students to point out the wear and damage in the systems.

2. Given access to an open tractor transmission and a dial indicator, the instructor may ask several students to check the tractor transmission end-play.

Examples of Evaluation Techniques:

1. Given a tractor transmission system, the student should be able to identify three conditions that may develop when proper maintenance is not performed.

2. Given a tractor transmission and new oil seals, the student should be able to replace the oil seals according to manufacturer's directions

Instructional Resources:

1. Access to a tractor transmission system
2. Tools appropriate to open up the system
3. Oil seals
4. Access to several used tractor transmission systems
5. Dial indicator
6. Extra transmission parts - shafts, gears, bearings, latches, shift levers, pivots, shims, thrust washers

Student Performance Objective 3:

Given a farm tractor and access to equipment and supplies, the student will select and use the appropriate equipment to check and/or change the transmission oil in farm tractors according to directions and specifications in appropriate service manual.

Instructional Areas:

1. Selecting transmission lubricants
    a. Determining viscosity requirements
    b. Determining service classification requirements
2. Checking oil levels
    a. Locating oil level dipstick or oil lever plug
    b. Checking dipstick
        (1) Wiping off excess oil
        (2) Reinserting completely and pulling out to check level
    c. Checking oil level from plug
        (1) Remove plug
        (2) Inserting finger to determine oil level
3. Draining and refilling transmission fluid
    a. Driving tractor until fluid is heated
    b. Parking tractor on a level surface
    c. Removing drain plug
        (1) Catching fluid in container
    d. Replacing transmission oil filter where appropriate
    e. Cleaning drain plugs
    f. Replacing and tightening drain plugs
    g. Cleaning dirt from filler plugs and surrounding area
    h. Removing the plug
    i. Refilling with proper amount of specified transmission fluid
    j. Replacing and tightening plugs
    k. Cleaning filler cap and breather where appropriate

Examples of Supporting References:

Supporting references were discussed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a farm tractor with transmission, the instructor may ask several students to check the fluid level in the transmission.
2. Given a tractor service manual, the instructor may ask two students to determine the type of transmission fluid to use in the given tractor transmission.

Examples of Evaluation Techniques:

1. Given access to an operational tractor transmission and appropriate transmission fluid, the student should be able to add fluid to the proper level according to manufacturer's recommendations.
2. Given a farm tractor, the student should be able to park the tractor in such a way that the tractor is level enough to change the transmission oil, according to manufacturer's recommendations.

Instructional Resources:

1. Tractor service manual
2. Access to tractor with operational transmission system
3. Appropriate transmission fluid
4. Charts on lubricant types
5. Appropriate tools for loosening plugs
6. Solvent for cleaning filler cap and breather where appropriate
7. Clean cloth to wipe dipstick

PAINTING AGRICULTURAL EQUIPMENT

CODE--01.0301

Module Concept: It is important that the Agricultural Equipment Mechanic is able to recondition equipment to increase the value and give longer life to agricultural equipment.

Prerequisites: Admission to the Agricultural Equipment Mechanics Program is sufficient evidence of qualification for entry into the course.

Module Goal: When this module of instruction is completed, the student should be able to apply basic knowledge and skills in reconditioning agricultural equipment.

Student Performance Objective 1: Given access to agricultural machinery to be cleaned before reconditioning and the equipment used for cleaning, the student will select and use the equipment to clean the agricultural machinery before reconditioning by following directions in appropriate operator's manual for equipment used.

Instructional Areas:

1. Identifying the precautions and procedures in using chemicals for cleaning agricultural equipment
   a. Using a solvent washer tank
   b. Determining safety precautions
2. Identifying the precautions and procedures in using steam cleaning for cleaning agricultural equipment
   a. Connecting the water supply
   b. Connecting the electrical source
   c. Determining the safety precautions
   d. Manipulating the nozzles
3. Identifying the precautions and procedures in using air for cleaning agricultural equipment
   a. Connecting the air hoses
   b. Manipulating the nozzles
   c. Determining the safety precautions

Examples of Supporting References:

1. "How To" Booklets. National Paint, Varnish and Lacquer Association, Inc., 1500 Rhode Island Avenue, N.W., Washington, D.C. 20005.

Examples of Student Learning Activities:

1. Given a steam cleaner, the instructor may ask three students to connect the steam cleaner to the water supply.

2. Given commercial solvent, the student should be able to clean a piece of agricultural equipment to the satisfaction of the instructor.

Examples of Evaluation Techniques:

1. Given a steam cleaner, the student should be able to list at least three safety precautions to observe while operating the equipment.

2. Given commercial solvent, the student should be able to clean a part from agricultural equipment by following the instructions of the solvent manufacturer.

Instructional Resources:

1. Access to steam cleaner
2. Access to a solvent washer tank
3. Commercial solvent
4. Access to an air compressor and hoses

Student Performance Objective 2:

Given access to cleaned agricultural machinery to be reconditioned and equipment used to sand and prepare the equipment for painting, the student will select and use the equipment to sand and featheredge machinery for painting by following directions of the equipment manufacturer.

Instructional Areas:

1. Sanding and featheredging for primer coat

    a. Wet sanding
    b. Dry sanding

2. Masking the equipment

    a. Using masking tape
    b. Using grease

Examples of Supporting References:

1. Phipps, Lloyd James. Farm Mechanics Test and Handbook. Danville, Illinois: The Interstate Printers and Publishers, Inc. 1964. pp. 204-225.

Examples of Student Learning Activities:

1. Given a rusty fender to a tractor, the instructor may have several students sand the fender for application of a primer coat.
2. The instructor may have three students demonstrate the use of wet sandpaper and explain under what conditions it can be used.

Examples of Evaluation Techniques:

1. The student should be able to list the parts to be masked on equipment for painting with 90% accuracy.
2. The student should be able to list at least two places where wet sandpaper could be used for sanding prior to painting.

Instructional Resources:

1. Rusty fender
2. Wet sandpaper
3. Dry sandpaper
4. Masking tape
5. Grease for masking

Student Performance Objective 3:

Given agricultural equipment to be painted, the student will select and mix the paint for application by following manufacturer's specifications.

Instructional Areas:

1. Selecting paints
    a. Determining types of primer paints
    b. Determining types of enamels
    c. Determining types of lacquers
2. Selecting thinners and solvents
3. Mixing paints
    a. Removing the lid and pouring out about one third
    b. Thoroughly mixing remainder with a circular motion until smooth and free of lumps
    c. Adding remaining paint and continue stirring until thoroughly mixed
4. Thinning paints
    a. Pouring paint into a larger container

   - b. Adding thinner as directed by manufacturer
   - c. Stirring thoroughly

5. Straining paints

   - a. Stirring the paint thoroughly
   - b. Straining through appropriate material

Examples of Supporting References:

In addition to references listed in Student Performance Objective 1 and 2, the following may be helpful:

1. Wakeman, T.J. and Vernon Lee McCoy. The Farm Shop. The MacMillan Company: New York. 1960.

Examples of Student Learning Activities:

1. The instructor may ask each student to visit a paint store, observe the various primer paints available and prepare a report on the different primer paints to use under differing conditions.

2. Given a can of paint, the instructor may have two students mix the paint until it is smooth and free of lumps.

Examples of Evaluation Techniques:

1. Given a can of enamel, the student should be able to thin the paint according to manufacturer's instructions.

2. Given a can of paint and appropriate straining material, the student should be able to strain the paint in such a way that it is free of all lumps.

Instructional Resources:

1. Cans of primer, enamel and lacquer paints
2. Empty cans for mixing
3. Stirring rods
4. Cans of thinners and solvents
5. Appropriate material for straining paints

Student Performance Objective 4:

Given access to cleaned and sanded agricultural equipment to be primed and mechanical spray painting equipment, the student will safely operate the equipment in applying the primer coat by following the appropriate manufacturer's directions.

Instructional Areas:

1. Preparing the paint equipment
    a. Hooking up hoses
    b. Adjusting regulator
    c. Adjusting suction feed
    d. Determining safety precautions that should be observed while operating spray painting equipment
2. Holding the spray gun properly
3. Spray painting with proper stroke
    a. Flat surface painting
    b. Corner painting

Examples of Supporting References:

Supporting references were listed in Student Performance Objectives 1,2, and 3.

Examples of Student Learning Activities:

1. The instructor may have two students use spray painting equipment to demonstrate the effects of holding the spray gun too far away and too close to the surface being painted.
2. Given a metal panel painted with paint runs, the instructor may have several students rub out the runs.

Examples of Evaluation Techniques:

1. The student should be able to list at least three safety precautions to be observed while spray painting.
2. Given spray painting equipment, the student should be able to hook up the hoses in such a way that there is no air or fluid leakage.

Instructional Resources:

1. Access to spray painting equipment
2. Access to a spray painting booth
3. Sand paper
4. Paint
5. Equipment to be painted

Student Performance Objective 5:

Given access to mechanical spraying equipment and the task of applying a finish coat(s) to agricultural equipment, the student will properly operate the equipment in applying the finish coat(s) so well that the finish coat(s) meets the approval of the instructor.

Instructional Areas:

1. Preparing the paint equipment
   a. Hooking up hoses
   b. Adjusting the regulator
   c. Adjusting suction feed
   d. Determining safety precautions that should be observed while operating spray painting equipment
2. Holding the spray gun properly
3. Spraying with the proper stroke
   a. Flat surface painting
   b. Corner painting
4. Correcting a poor past application and touching up
   a. Identifying poorly painted areas
   b. Sanding featheredges
   c. Applying a fine coat of paint
   d. Rubbing out defective spots
5. Applying stencils and decals
   a. Wet type
   b. Dry type

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 3.

Examples of Student Learning Activities:

1. Given access to spray painting equipment, the instructor may ask two students to demonstrate the proper method of holding the spray gun.
2. Given a wet type stencil and newly painted agricultural equipment, the instructor may have one student apply a wet type decal to the equipment

Examples of Evaluation Techniques:

1. Given mechanical painting equipment, the student should be able to demonstrate at least three safety precautions to observe while operating the equipment.

2. The student should be able to identify the poorly painted areas with 90% accuracy.

Instructional Resources:

1. Access to spray painting equipment
2. Access to a spray painting booth
3. Appropriate clothing and equipment
4. Sand paper
5. Paint
6. Equipment to be painted
7. Wet and dry stencils

Student Performance Objective 6:

Given the task of touching-up agricultural equipment manually with hand tools, the student will select and use hand tools in touching-up the equipment so well that the finished product meets the approval of the instructor.

Instructional Areas:

1. Selecting paint brushes for touch-up

    a. Determining brush width and type

2. Mixing paint

    a. Removing lid, pour off paint to make room for stirring
    b. Stirring thoroughly
    c. Adding thinner as directed
    d. Stirring thoroughly
    e. Straining paint

3. Applying paint with a brush

    a. Dipping brush into paint about one-third length of bristles
    b. Removing excess paint by scraping the bristles over inside rim of paint bucket
    c. Brushing on paint with the grain or horizontally
    d. Applying enough pressure to slightly bend the bristles
    e. Brushing out paint into a smooth, thin coat
    f. Lifting the brush gradually as it nears the end of the stroke

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 3.

Examples of Student Learning Activities:

1. Given access to several paint brushes, the instructor may ask a student to select the most suitable paint brush for a given touch-up job.

2. Given a new can of factory-made paint, the instructor may ask two students to determine the amount and type of thinner required by reading label directions.

Examples of Evaluation Techniques:

1. Given a can of paint, the student should be able to stir the heavy paste at the bottom of the can into the free vehicle by following manufacturer's directions.

2. Given a paint brush and a can of properly mixed paint, the student should be able to apply a finish coat of paint to a given prepared piece of metal in such a way that the coat of paint, after drying, is smooth and evenly applied.

Instructional Resources:

1. New can of factory-made paint
2. Sufficiently large stirring container
3. Appropriate thinner
4. Window screen for straining
5. Stirring paddles
6. Selection of paint brushes
7. 2"x3" metal plates to be painted

Student Performance Objective 7:

Given the task of servicing and cleaning mechanical spraying equipment and cleaning manual tools, the student will select tools and solutions to service and clean mechanical equipment and clean manual equipment so well that the servicing and cleaning tasks are performed according to manufacturer's directions.

Instructional Areas:

1. Identifying the types of spray guns
    a. Separate containers and attached containers
    b. Bleeder and non-bleeder types
    c. External mix and internal mix

- d. Pressure, gravity and suction feed
- e. Automatic and extension types

2. Identifying components of a spray gun

    - a. Air cap

        - (1) External mix
        - (2) Internal mix
        - (3) Multi-jet mix

    - b. Fluid tip
    - c. Fluid needle
    - d. Trigger
    - e. Fluid adjusting screw
    - f. Air valve
    - g. Spreader adjusting valve
    - h. Gun body

3. Removing, cleaning and lubricating spray head

    - a. Removal
    - b. Head cleaning procedure

        - (1) Immersing
        - (2) Air with solution

4. Identifying components of the spray unit

    - a. Hoses and connectors
    - b. Regulators
    - c. Air compressors

        - (1) Intake and exhaust valves
        - (2) Cylinder
        - (3) Crankcase
        - (4) Crankshaft
        - (5) Air filter
        - (6) Automatic unloader
        - (7) Automatic pressure switch
        - (8) Motor protection
        - (9) Motor

    - d. Respirators

        - (1) Hood type
        - (2) Absorbing type
        - (3) Dust type with filter

    - e. Spray booths

        - (1) Dry type
        - (2) Air washer type

    - f. Exhaust fans

5. Servicing spray units
    a. Stopping air leakage
    b. Stopping fluid leakage
    c. Compressor knock
    d. Compressor heats up
    e. Compressor operates longer than normal
    f. Compressor pumps oil
    g. Booth maintenance

6. Caring for a new paint brush
    a. Working out loose bristles
    b. Dipping brush into raw linseed oil
    c. Removing excess oil

7. Caring for and cleaning a paint brush
    a. Pouring cleaner into a clean container
    b. Working bristles in cleaner until paint is dissolved
    c. Removing cleaner by wiping brush over edge of container and drying with a clean cloth
    d. Rinsing brush in fresh cleaner and drying
    e. Wrapping the brush in heavy paper and storing in a flat position with bristles straight

Examples of Supporting References:

In addition to supporting references discussed in Student Performance Objectives 1 and 2, the following maybe helpful:

1. Crewdson, F.N. Spray Painting, Industrial and Commercial. Frederick J. Drake and Co., Skokie, Illinois. 1957.

Examples of Student Learning Activities:

1. Given several types of spray guns, the instructor may have several students identify the different types and explain their operation.

2. Given a clogged spray head, the instructor may have several students clean the head.

3. Given a spray booth, the instructor may have several students clean out the booth after painting in the booth.

4. Given a new paint brush, the instructor may ask the student to go through the steps that would best care for the brush before it is used for painting.

5. Given a cleaned paint brush, the instructor may ask a student to prepare the brush for storing by wrapping properly in appropriate paper.

Examples of Evaluation Techniques:

1. Given a spray gun, the student should be able to disassemble and identify at least six components of the spray gun.

2. Given a spray unit leaking air, the student should be able to make the necessary repairs to stop the air leak.

3. Given a paint brush with fresh paint on it, the student should be able to follow the manufacturer's directions in cleaning and storing the brush.

4. Given a new paint brush, the student should be able to demonstrate at least two things that should be done with the brush before using it for painting.

Instructional Resources:

1. New paint brushes
2. Old paint brushes
3. Raw linseed oil
4. Empty paint containers
5. Clean cloths
6. Paint cleaning fluid
7. Heavy paper
8. Access to different types of spray guns
9. Access to spray equipment and booth
10. Solution for cleaning spray equipment
11. Tools for disassembling spray equipment
12. Appropriate protective clothing

Student Performance Objective 8:

Given the task of storing manual and mechanical spraying equipment and other materials used in painting agricultural equipment, the student will organize and store the spraying equipment and materials in a specified area so well that the storing of the equipment and materials meets the approval of the instructor.

Instructional Areas:

1. Storing paint brushes

   a. Wrapping in heavy paper
   b. Laying in a flat position

2. Storing mechanical spraying equipment

   - a. Cleaning equipment for storage
   - b. Applying oil where appropriate
   - c. Selecting appropriate storage area

3. Storing paint supplies
   - a. Tightening all lids and tops of containers
   - b. Observing safety precautions in storage of flammable materials

4. Storing paint equipment
   - a. Providing storage for paint clothing
   - b. Storing sander and other equipment

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1,2,3, and 7.

Examples of Student Learning Activities:

1. Given spray painting equipment, the instructor may have several students indicate the lubrication points on the equipment prior to storage.

2. Given an open can of paint, the instructor may ask two students to prepare the can of paint for long-term storage.

Examples of Evaluation Technqiues:

1. Given a piece of heavy paper and a clean paint brush, the student should be able to prepare the brush for storage by wrapping it in the paper in such a way that the bristles remain straight and the brush is well protected from dust.

2. Given flammable paint materials for storage, the student should be able to determine at least three safety factors to consider in storage of the flammable materials.

Instructional Resources:

1. Heavy wrapping paper
2. Clean paint brush
3. Access to spray painting equipment
4. Lubrication material for spray painting equipment
5. Appropriate cleaning agent for spray painting equipment
6. Can of paint
7. Flammable paint material

SET OF MODULES FOR PREPARING
FARM EQUIPMENT OPERATORS
(SEE THE LIST OF STUDENT PERFORMANCE OBJECTIVES FOR
THE LOCATION(S) OF MODULES NOT FOUND HERE)

UNDERSTANDING FARM SAFETY AND USING SAFETY PRECAUTIONS IN OPERATING FARM TRACTORS AND EQUIPMENT

CODE--01.0301

Module Concept: Tractors are essential to modern agriculture. Unfortunately, an estimated 1,000 fatalities result in the U.S.A. each year from tractor accidents. Most of the accidents could be avoided by competent operation of tractors, the use of protective equipment and proper maintenance of the equipment. It is important to learn the safety rules in operating farm tractors. It is even more important to learn how to operate the farm tractor by applying the rules.

There are also legal obligations which are intended to reduce accidents. The farm Equipment Operator must be able to operate a tractor safely, legally, and efficiently.

Prerequisites: Admission to the Farm Equipment Operator program is sufficient evidence of qualification for entry into this course.

Module Goal: When this module is completed, the student will use the recognized safety rules in operating farm tractors and equipment efficiently and safely under normal conditions.

Student Performance Objective 1: Given information regarding the safe operation of farm tractors, self-propelled combines, farm trucks, and other types of farming equipment, the student will perform the following tasks:

a. Demonstrate and explain reasons why one should be physically capable of operating farm equipment
b. Demonstrate and explain reasons why one should be physiologically capable of operating farm equipment
c. Demonstrate and explain reasons why one should be psychologically capable of operating farm equipment
d. Explain safety precautions necessary for the safe operation of farm equipment
e. Identify and explain various safety driving symbols
f. Demonstrate the proper use of hand signals as published by the American Society of Agricultural Engineers (ASAE)

so that when the student is confronted with operating farm equipment, he/she will be proficient in operating the equipment in a safe and efficient manner.

Instructional Areas:

1. Determining the minimum physical characteristics required to operate farm equipment
   - a. Working in a safe manner to avoid muscle fatigue
   - b. Reaction time
   - c. Body size
   - d. Age
     - (1) State regulations
     - (2) Federal regulations
   - e. Vision
   - f. Determining noise exposure permissable
2. Considering physiological factors related to driving a tractor
   - a. Avoiding fatigue
   - b. Avoiding drugs, alcohol and tobacco
   - c. Avoiding chemicals
   - d. Effects of illness on ability to work
   - e. Effects of environmental conditions
     - (1) Temperature and humidity
     - (2) Vibration
     - (3) Noise
3. Considering psychological factors related to operating farm equipment
   - a. Personal conflict
   - b. Personal tragedy
   - c. Interpersonal problems
   - d. Vocational problems
   - e. Financial difficulties
   - f. Insecurity
4. Determining safety precautions necessary for safe operation of farm equipment
   - a. Using protective equipment
     - (1) Head
     - (2) Hands
     - (3) Ears
     - (4) Eyes
     - (5) Feet
     - (6) Body
     - (7) Respiratory

b. Using proper lifting techniques
c. Using machines

(1) Knowing and being able to use controls
(2) Determining capacity of the machine
(3) Determining operation conditions of the machine

d. Identifying common machine hazards

5. Identifying symbols

a. Safety Alert Symbols
b. Signal words
c. Safety signs and their colors
d. Universal symbols
e. SMV Emblem

6. Identifying and using hand signals

Examples of Supporting References:

1. *Fundamentals of Machine Operation - Agricultural Machinery Safety*. Moline, Illinois: Deere and Company. 1974

2. *Farm and Ranch Safety Guide*. Chicago, Illinois: National Safety Council. 1973.

Examples of Student Learning Activities:

1. Given a set of plastic or rubber earplugs, the instructor will ask one student to demonstrate the use of earplugs.

2. Given a farm tractor, the instructor will ask two students to demonstrate how body size affects the safe operation of the tractor.

Examples of Evaluation Techniques:

1. Given ten safety symbols commonly found on the roadway, the student will correctly identify the symbols with 100% accuracy.

2. Given a task of operating a given piece of agricultural equipment, the student will point out at least five hazards to consider in operating the equipment.

Instructional Resources:

1. Access to various agricultural equipment
2. Ear plugs
3. Access to various items of protective clothing to be used or worn in operating agricultural equipment
4. Charts of agricultural equipment with hazard points indicated

Student Performance Objective 2:

Given access to various types of farm tractors (carburetor and diesel) without implement attachments, the student will perform the following tasks:

- a. Identify and explain the functions of the controls, instruments and other parts on farm tractors
- b. Check fuel, oil, battery, and radiator if applicable
- c. Start engine
- d. Start the tractor movement forward
- e. Operate the tractor while in forward motion
- f. Stop the forward movement of the tractor
- g. Start, operate and stop the movement of the farm tractor while backing up

so that when the student is given the task of operating the tractor under field conditions, he/she will be capable of operating the equipment in a safe and efficient manner.

Instructional Areas:

1. Identifying and explaining functions of various tractor controls
    - a. Steering controls
    - b. Clutching controls
    - c. Braking mechanism
    - d. Lighting system
    - e. Windshield wiper
2. Identifying and explaining functions of various instruments
    - a. Fuel level gauge
    - b. Engine oil pressure light
    - c. Transmission oil temperature light
    - d. Ammeter or generator light
    - e. Engine water temperature gauge
    - f. Engine RPM gauge

3. Making preoperational checks to the tractor
    a. Checking fuel level
    b. Checking battery
    c. Checking coolant level in radiator
4. Starting the tractor engine
    a. Providing adequate ventilation if inside
    b. Moving tractor outside for adjustments
    c. Starting tractor only from operator's platform
    d. Disengaging PTO before starting
    e. Shifting to neutral or park before starting
    f. Engaging the starter
5. Starting the tractor movement forward
    a. Looking ahead and to the rear
    b. Engaging power to drive wheels slowly
6. Operating the tractor while in forward motion
    a. Signaling before turning
    b. Slowing down before braking
7. Stopping the tractor
    a. Signaling before stopping
    b. Pulling over on right shoulder on highways
    c. Slowing down before braking
    d. Pumping brakes when stopping on slippery surfaces
    e. Using care in stopping with heavy loads
    f. Shifting to park or setting parking brake
    g. Lowering all equipment after stopping
    h. Turning off electrical switches
8. Backing up a tractor
    a. Looking ahead and to the rear
    b. Engaging power to drive wheels slowly

Examples of Supporting References:

In addition to supporting references listed in Student Performance Objective 1, the following will be helpful:

1. Tractors, Fundamentals of Machine Operation. Moline, Illinois: John Deere Service Publications.

2. Manufacturers' Operator's Manuals
3. State Vehicle Operator's Manual or regulations

Examples of Student Learning Activities:

1. While sitting on a tractor seat, looking at the controls, the instructor may ask a student to identify the fuel gauge and determine the amount of fuel in the fuel tank.
2. Given a farm tractor, the instructor may ask a student to start the tractor, engage the power to the drive wheels and stop the tractor in a safe manner.

Examples of Evaluation Techniques:

1. Given a farm tractor, the student will perform preoperational checks on at least three vital systems.
2. While operating a tractor in a forward direction, the student will give the appropriate hand signal for a right hand turn prior to executing a right hand turn.

Instructional Resources:

1. Access to a farm tractor
2. Charts of hand signals
3. Tractor operating manual

SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM TILLAGE EQUIPMENT

CODE--01.0301

Module Concept:

Tillage brings about the physical changes in the soil which improves crop growing conditions. Performing the tillage job well reduces secondary tillage before planting the crop.

Economic tillage with modern tractors and properly adjusted equipment is essential to the farmer. Performing the task safely is extremely important.

Prerequisites:

The module "Understanding Farm Safety and Using Safety Precautions in Operating Farm Tractor and Equipment" should be completed before this module is undertaken.

Module Goal:

At the completion of this module, the student will select and operate tillage equipment in a safe and efficient manner in preparing a satisfactory seed bed for a crop.

Student Performance Objective 1:

When provided with information concerning the number of acres and type of soil to be prepared for planting, the student will select and operate the appropriate tractor and tillage equipment so that when the student is confronted with selecting and operating farm tillage equipment, he/she will be proficient in operating the equipment in a safe and efficient manner by following directions in the appropriate operator's manual.

Instructional Areas:

1. Selecting tillage equipment
    a. Moldboard plows
        (1) Determining the purpose
        (2) Determining the size required
    b. Disk plows
        (1) Determining the purpose
        (2) Determining the type
        (3) Determining the size required

2. Selecting the tractor to pull selected tillage equipment
   - a. Determining the horsepower required
   - b. Determining weight required to operate selected equipment
   - c. Determining wheel arrangement
   - d. Determining hydraulic power requirements

3. Attaching tillage equipment to a tractor
   - a. Hitching the drawn moldboard plow
     - (1) Connecting plow to drawbar with center of load behind center line of pull
     - (2) Placing plow hitch in line of pull
   - b. Hitching the integral mounted moldboard plow
     - (1) Connecting hydraulic power
     - (2) Connecting hitchpoints
   - c. Hitching the drawn disk plow
     - (1) Connecting plow to drawbar
     - (2) Setting the scrapers
   - d. Hitching integral mounted disk plow
     - (1) Connecting hydraulic power
     - (2) Connecting hitchpoints

4. Operating tillage equipment
   - a. Starting the tractor
   - b. Dropping the plow in the ground
   - c. Plowing a straight furrow
   - d. Turning around at the end of the field
   - e. Observing all safety considerations in plowing

5. Adjusting tillage equipment

Examples of Supporting References:

1. Plows and Plowing. Columbus, Ohio: The Ohio Agricultural Education Curriculum Materials Service. 1969.

2. The Operation, Care and Repair of Farm Machinery. Moline, Illinois: Deere and Company. Current edition.

3. Farm and Ranch Safety Guide. Chicago, Illinois: National Safety Council. 1973.

4. Service manuals for given equipment

Examples of Student Learning Activities:

1. While driving a tractor hooked up to a plow, the instructor may have several students take turns in picking a land mark and plowing a straight furrow without looking back.

2. Given a tractor with known horsepower, the instructor may have several students determine the largest moldboard plow, in both size and type, that the tractor can efficiently pull.

Examples of Evaluation Techniques:

1. Given a tractor and attached plow, the student will plow a straight furrow from end-to-end of the field.

2. Given a moldboard plow, the student will determine the center of pull on the tractor within recognized guidelines.

Instructional Resources:

1. Access to a farm tractor
2. Access to a variety of plows
3. Access to a field to be plowed
4. Operator's manuals for both tractors and plows

Student Performance Objective 2:

Given access to a farm tractor and tillage equipment that has been used in preparing the soil for planting, the student will clean, lubricate and store the tractor and tillage equipment by following recommendations in given service manuals so that the equipment will operate safely and efficiently when used again to prepare soils for planting.

Instructional Areas:

1. Washing the tractor

   a. Using high water pressure hoses
   b. Using air pressure

2. Cleaning tillage equipment
    a. Scraping off all dirt and cleaning the equipment
    b. Greasing land-polished surfaces for storage

3. Lubricating and servicing the farm tractor
    a. Lubricating all moving parts by following guides for given tractor
    b. Servicing tractors at stated intervals
        (1) Crankcase ventilating system
        (2) Oil filler breather cap
        (3) Pressure type fittings
        (4) Crankcase dipstick
        (5) Hydraulic system dipstick
        (6) Air cleaner
        (7) Fuel filter
        (8) Distributor
        (9) Rear axle
        (10) Transmission
        (11) Steering housing
        (12) Power steering
        (13) Pedestal
        (14) Final drive housing
        (15) Generator
        (16) Other as designated in service manual

4. Lubricating and servicing tillage equipment
    a. Lubricating all pressure type grease fittings
    b. Oiling all other moving parts
    c. Adjusting wheel bearings
    d. Checking tire inflation
    e. Inspecting shear pins
    f. Inspecting trip beams
    g. Tightening all bolts and screws

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a farm tractor and plow after a plowing operation, the instructor may have two students scrap the dirt off the plow.

2. Given a plow and tire gauge, the instructor may have several students check the tire pressure.

Examples of Evaluation Techniques:

1. Given a tire gauge, access to air pressure and an operator's manual for a given plow, the student will check the tire pressure and add or let out air in such a way that the tire pressure is within two pounds of the suggested pressure in the operator's manual.

2. Given a farm tractor and operator's manual, the student will locate 90% of the pressure grease fittings.

Instructional Resources:

1. Access to a farm tractor and operator's manual
2. Access to a plow and operator's manual
3. Access to air pressure
4. Access to water pressure
5. Equipment used to scrap dirt from tractor and plows
6. Grease gun
7. Appropriate types and kinds of lubricants
8. Clean cloths

SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM FERTILIZER APPLICATION EQUIPMENT

CODE--01.0301

Module Concept: Fertilizer is necessary for the high yields of modern agriculture. The increasing cost of fertilizer makes it very important that the fertilizer be applied at a time and in a way that maximum yields will be produced. As a result, the use, care and service of fertilizer application equipment is important to the farmer for both efficiency and economy.

This module will depict for the instructor areas which should be taught relative to performing fertilizer application operations to enable the student to select, operate, adjust, service and store fertilizer application equipment effectively, economically and safely.

Prerequisites: The module "Understanding Farm Safety and Using Safety Precautions in Operating Farm Tractors and Equipment" should be completed before this module is undertaken.

Module Goal: At the completion of this module, the student will operate fertilizer equipment in a safe and efficient manner in applying fertilizer to a crop.

Student Performance Objective 1: When provided with information concerning the number of acres and the type of soil to be fertilized, the student will select and operate the appropriate tractor and fertilizer application equipment so that when the student is confronted with selecting and operating fertilizer application equipment, he/she will be proficient in operating the equipment in a safe and efficient manner by following directions in appropriate operator's manual.

Instructional Areas:

1. Selecting fertilizer application equipment

    a. Type of fertilizer to be applied

        (1) Dry fertilizer
        (2) Liquid fertilizer

   - b. Determining the size of equipment most economical

2. Selecting the tractor to operate selected fertilizer application equipment
   - a. Determining the horsepower required
   - b. Determining wheel arrangement
   - c. Determining hydraulic power requirements

3. Attaching fertilizer application equipment to a tractor
   - a. Hitching equipment to the drawbar
   - b. Connecting hydraulic power
   - c. Connecting all hitchpoints

4. Filling applicator with fertilizer
   - a. Wearing appropriate safety equipment
   - b. Observing safety precautions
   - c. Filling the hopper where appropriate
   - d. Filling the tank where appropriate

5. Operating the tractor in applying the fertilizer
   - a. Starting the tractor
   - b. Driving at the appropriate speed
   - c. Turning around at the end of the field
   - d. Observing all safety considerations in applying fertilizer

6. Adjusting the fertilizer application equipment
   - a. Adjusting for depth of application
   - b. Adjusting for rate of application
     - (1) Sprocket combinations in dry fertilizer
     - (2) Orifice disk of metering head for liquid fertilizer

Examples of Supporting References:

1. The Operation, Care and Repair of Farm Machinery. Moline, Illinois: Deere and Company. Current edition.

2. Service manuals and operator's instructions for the fertilizer application equipment being used.

Examples of Student Learning Activities:

1. The instructor may ask several students to visit local farm equipment machinery dealers and report to the class the various types of fertilizer application machines that are available.
2. Given a fertilizer applicator and a bag of fertilizer, the instructor may ask a student to put the bag of fertilizer in the fertilizer applicator hopper in a safe manner.

Examples of Evaluation Techniques:

1. Given a fertilizer applicator and an operator's manual, the student will identify within 10% the amount of horsepower required to operate the applicator.
2. Given a fertilizer applicator, the student will adjust the depth of application of the applicator to within ½ inch of the recommended application depth.

Instructional Resources:

1. Access to a farm tractor
2. Access to various types of fertilizer applicators
3. Bag of fertilizer
4. Field on which fertilizer can be applied

Student Performance Objective 2:

Given access to a farm tractor and fertilizer applicator that has been used in applying fertilizer, the student will clean, lubricate and store fertilizer application equipment by following recommendations in given service manual so that the equipment will operate safely and efficiently when again used to apply fertilizer.

Instructional Areas:

1. Washing the tractor
    a. Using high pressure water hoses
    b. Using air pressure

2. Cleaning the fertilizer application equipment
    a. Scraping off all dirt
    b. Cleaning fertilizer hopper and delivery tubes
        (1) Removing assemblies
        (2) Flushing out loose fertilizer
        (3) Removing caked fertilizer
3. Lubricating and servicing the farm tractor
    a. This information has been covered in Student Performance Objective 2 in the module "Operating, Adjusting, Servicing and Storing Farm Tillage Equipment."
4. Lubricating and servicing fertilizer applicators
    a. Lubricating all pressure type grease fittings
    b. Oiling all moving parts
    c. Adjusting wheel bearings
    d. Checking tire inflation
    e. Tightening all bolts and screws
    f. Replacing worn parts
5. Storing fertilizer applicators
    a. Dry fertilizer applicators
        (1) Removing auger assemblies
        (2) Tipping hopper over and emptying
        (3) Flushing out all loose fertilizer
        (4) Cleaning out caked fertilizer
        (5) Coating all unpainted parts with oil or light grease
        (6) Repainting hoppers and augers
        (7) Drying painted and washed equipment
        (8) Reassembling for storage
        (9) Storing in a dry location
    b. Liquid fertilizer applicators
        (1) Removing liquid fertilizer from tank
        (2) Disassembling distributor valves and metering heads
        (3) Washing all parts with clean water and mild detergent
        (4) Assembling distributor valves and metering heads
        (5) Completely dry tanks
        (6) Oiling all parts
        (7) Storing in a dry location

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a liquid fertilizer applicator after use, the instructor may ask several students to clean the equipment which will be used in the same cropping season.

2. Given the task of lubricating a fertilizer applicator, the instructor may ask two students to select and use the appropriate grease gun on the grease fittings of the equipment.

Examples of Evaluation Techniques:

1. Given a dry fertilizer applicator, the student will remove the auger assemblies without injurying himself/herself or damaging the equipment.

2. Given a fertilizer applicator and an operator's manual for the equipment, the student will identify all the grease fittings on the applicator.

Instructional Resources:

1. Access to fertilizer applicators
2. Appropriate grease guns and grease
3. Access to high water pressure
4. Access to air pressure
5. Tools for scraping dirt off equipment
6. Tools for disassembling and assembling fertilizer applicators
7. Oil and cloths

SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM PLANTING EQUIPMENT

CODE--01.0301

Module Concept:

Planting the seed correctly is very important to producing the best yield possible. The planting of seeds at the right depth, with the correct amount of seeds is the fucntion of the planting equipment.

This module with depict for the instructor areas which should be taught relative to operating, adjusting, servicing and storing the farm planting equipment in such a way that the student will be able to effectively and economically use planting equipment.

Prerequisites:

The module "Understanding Farm Safety and Using Safety Precautions in Operating Farm Tractors and Equipment" should be completed before this module is undertaken.

Module Goal:

At the completion of this module, the student will operate planting equipment in a safe and efficient manner in planting seeds.

Student Performance Objective 1:

When provided with information regarding the number of acres and type of soil to be planted, the student will select and operate the appropriate tractor and planting equipment so that when the student is confronted with selecting and operating farm planting equipment, he/she will be proficient in operating the equipment in a safe and efficient manner by following directions in the appropriate operator's manual.

Instructional Areas:

1. Selecting the planting equipment

    a. Determining type of planting equipment

        (1) Grain drills
        (2) Row crop planter
        (3) Fertilizer planters

   b. Determining the size of equipment required

2. Selecting the tractor size and type to operate selected planting equipment
   - a. Determining horsepower required
   - b. Determining wheel arrangement
   - c. Determining hydraulic power requirements

3. Attaching planting equipment to the farm tractor
   - a. Hitching the equipment to the drawbar
   - b. Connecting hydraulic power
   - c. Connecting all hitchpoints

4. Adjusting the planting equipment
   - a. Selecting gears
   - b. Adjusting gears
   - c. Adjusting row spacing
   - d. Adjusting planting depth
   - e. Adjusting markers
   - f. Inserting seed plates
   - g. Adjusting fertilizer placement
   - h. Adjusting runners
   - i. Adjusting valves
   - j. Adjusting feed shifters

5. Operating the equipment in planting
   - a. Driving steadily and evenly
   - b. Turning planter off and on
   - c. Turning around at the end of the field
   - d. Observing safety factors

Examples of Supporting References:

1. Farm Machinery and Equipment. New York, New York: McGraw Hill and Company.
2. Service manuals and operator's instructions for the planting equipment being used.

Examples of Student Learning Activities:

1. Given a corn crop of 100 acres to plant and a given size farm tractor, the instructor may ask several students to determine the type and size of corn planter that would do the task most efficiently and economically.
2. When planting wheat with a tractor and grain drill, the instructor may ask a student to hitch the drill so that the box is tilted slightly forward to get better penetration in hard seed beds.

Examples of Evaluation Techniques:

1. While changing plates in a row crop planter for a different size seed, the student will select the correct plate for planting corn.

2. Given a grain drill with a land measurer, the student will select the appropriate equipment and set the measurer back to zero.

Instructional Resources:

1. Access to a grain drill
2. Access to a row crop planter
3. Appropriate size tractor to pull the equipment
4. Selection of gears and seed plates for the planters
5. Seed to plant
6. Field prepared for seed planting
7. Equipment to adjust land measurer
8. Tool to attach planting equipment to tractor

Student Performance Objective 2:

Given access to a farm tractor and planting equipment to be stored after planting seeds, the student will clean, lubricate and store farm planting equipment by following recommendations in given service manuals so that the equipment will operate safely and efficiently when again used to plant other types of seeds.

Instructional Areas:

1. Washing the tractor

    a. Using high pressure water hoses
    b. Using air pressure

2. Cleaning planting equipment

    a. Scraping off all dirt
    b. Cleaning out all seed after season is completed
    c. Unclogging seed boots at regular intervals

3. Lubricating and servicing the farm tractor

    a. This information has been covered in Student Performance Objective 2 in the module "Selecting, Operating, Adjusting, Servicing and Storing Farm Tillage Equipment"

4. Lubricating and servicing planting equipment

    a. Lubricate all pressure type grease fittings
    b. Oiling all moving parts
    c. Tightening all bolts and nuts
    d. Checking tire inflation
    e. Adjusting wheel bearings
    f. Changing gear case oil

5. Storing planting equipment

    a. Grain drills

        (1) Cleaning out all seed
        (2) Cleaning and oiling opener surfaces
        (3) Placing machine under shelter
        (4) Greasing all pressure gun fittings

    b. Row-crop planters

        (1) Cleaning all seed out
        (2) Changing gear case oil at beginning of planting season
        (3) Cleaning and oiling opener surfaces
        (4) Placing machine under shelter
        (5) Greasing all pressure gun fittings
        (6) Checking for alignment at beginning of planting season

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a grain planter and the appropriate wrenches, the instructor may have several students check all the bolts on the planter for tightness.

2. Given a grain planter, oil and cloths, the instructor may have several students apply oil to the opener surfaces.

Examples of Evaluation Techniques:

1. Given a grain drill that is to be stored for the winter, the student will describe to the class at least three tasks that should be performed to properly store the machinery.

2. Given a grain planter containing seed, the student should be able to clean up the machinery in such a way that all the seed has been removed from the machine.

Instructional Resources:

1. Access to a grain drill
2. Access to a row crop planter
3. Appropriate grease gun and lubricant
4. Oil and cloths
5. Appropriate wrenches to check all bolts for tightness on the equipment the student is working on
6. Tire gauge
7. Service manuals for machines to be worked on

SELECTING, OPERATING, ADJUSTING, SERVICING AND STORING FARM CULTIVATION EQUIPMENT

CODE--01.0301

Module Concept:

The control of weeds is essential to produce the highest yield of a grain crop. Cultivation is one method of controlling weeds. Cultivation also creates a moisture saving surface mulch and admits air and light to the soil. The Farm Equipment Operator's ability to use cultivation equipment is necessary to perform his/her work.

This module will depict for the instructor areas which should be taught relative to operating cultivation equipment to enable the student to operate, adjust, service and store the cultivation equipment economically and safely.

Prerequisites:

The module "Understanding Farm Safety and Using Safety Precautions in Operating Farm Tractors and Equipment" should be completed before this module is undertaken.

Module Goal:

At the completion of this module, the student will operate cultivation equipment in a safe and efficient manner in cultivating a row crop.

Student Performance Objective 1:

When provided with information regarding the number of acres and type of soil in which plants are being grown, the student will select and operate the appropriate tractor and cultivation equipment so that when the student is confronted with selecting and operating farm cultivation equipment, he/she will be proficient in operating the equipment in a safe and efficient manner by following directions in the appropriate operator's manual.

Instructional Areas:

1. Selecting cultivation equipment

    a. Considering type of crop to be cultivated
    b. Determining the size of equipment required
    c. Determining the type of sweep for the job

2. Selecting the tractor to operate the selected cultivation equipment
   a. Determining the horsepower required
   b. Determining the wheel arrangement
   c. Determining hydraulic power requirements

3. Attaching cultivation equipment to the tractor
   a. Driving tractor up to cultivator
   b. Connecting all hitchpoints
   c. Connecting hydraulic power

4. Operating the tractor in cultivating
   a. Starting the tractor
   b. Driving at the appropriate speed
   c. Touching control levers at the end of the field to raise the rigs
   d. Turning without stopping
   e. Observing all safety considerations in operating cultivator

5. Adjusting the cultivator
   a. Setting the shovels for depth
   b. Adjusting the pitch of the shovels

Examples of Supporting References:

1. The Operation, Care and Repair of Farm Machinery Moline, Illinois: Deere and Company. Current edition.

2. Service manuals and operator's instructions for cultivation equipment being used

Examples of Student Learning Activities:

1. Given a farm tractor and a row crop cultivator that can be used with the selected tractor, the instructor may ask a student to drive the tractor up to the cultivator for the purpose of attaching the cultivator.

2. Given a specific weed problem, the instructor may ask several students to report on the type of sweep that would most efficiently eliminate the weed problem, and why they selected the sweep they did.

Examples of Evaluation Techniques:

1. Given a farm tractor with attached cultivator, the student shall be able to operate the equipment in such a way that he/she turns at the end of the field without stopping the tractor to lift the cultivator rig and without cultivating out any crop plants.

2. Given a farm tractor with attached cultivator, while cultivating a row crop, the student will drive the tractor once down the field at the speed recommended in the operator's manual for the cultivator within one mile per hour of the recommended speed.

Instructional Resources:

1. Access to a farm tractor
2. Access to a row crop cultivator
3. Access to a field with a growing row crop to be cultivated
4. Tools appropriate to attach cultivator to tractor

Student Performance Objective 2:

Given access to a farm tractor and cultivator which has been used to cutlivate grain crops, the student will clean, lubricate and store the tractor and cultivator equipment by following recommendations in given service manuals so that the equipment will operate safely and efficiently when again used to cultivate additional grain crops.

Instructional Areas:

1. Washing the tractor
    a. Using high pressure water hoses
    b. Using air pressure
2. Cleaning cultivator equipment
    a. Scraping off all dirt
    b. Polishing and coating shovels with oil when standing overnight
3. Lubricating and servicing the farm tractor
    a. This information has been covered in Student Performance Objective 2 in the module "Operating, Adjusting, Servicing and Storing Farm Tillage Equipment."
4. Lubricating and servicing the cultivation equipment

   - a. Lubricating all pressure type grease fittings
   - b. Oiling all moving parts
   - c. Adjusting wheel bearings
   - d. Tightening all bolts and screws
   - e. Sharpening cultivator shovels
   - f. Replacing badly worn shovels
   - g. Polishing rusted or pitted shovels

5. Storing cultivation equipment
   - a. Polishing shovels and covering with heavy grease
   - b. Storing in a dry location

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a cultivator that was used in wet soil and to be used the next day, the instructor may ask several students to polish the shovels and apply a light coat of oil.

2. Given a dull cultivator shovel, the instructor may ask several students to locate a business that will properly sharpen the shovels.

Examples of Evaluation Techniques:

1. Given badly worn and nearly new cultivator shovels, the student will correctly determine which shovel is worn.

2. Given a cultivator with worn shovels, the student will remove the worn shovels and replace them with reconditioned shovels without injury and in such a way that the cultivator operates as designed.

Instructional Resources:

1. Access to a farm tractor with cultivator
2. Access to water under pressure and air pressure
3. Tools for scraping dirt off cultivators
4. Grease gun and appropriate lubricants
5. Heavy grease for cultivator shovels
6. Examples of nearly new and badly worn shovels

SELECTING, OPERATING, ADJUSTING, SERVICING, AND STORING FARM EQUIPMENT USED IN CONTROLLING WEEDS, INSECTS AND OTHER PESTS

CODE--01.0301

Module Concept:

There are crop insects and pests that reduce crop yields and at times destroy entire crops. Plants that escape infestation or infection must compete with weeds. In modern agriculture there are many chemicals used to control insects, diseases, pests and weeds. Spray or dust application of the appropriate chemicals by modern and well designed equipment can given the farmer rapid and thorough results. As a result, the use, care and servicing of spraying and dusting equipment is important to the farmer for both efficiency and economy.

This module will depict for the instructor areas which should be taught relative to performing spraying and dusting operations to enable the student to operate, adjust, service and store the application equipment effectively, economically and safely.

Prerequisites:

The module "Understanding Farm Safety and Using Safety Precautions in Operating Farm Tractors and Equipment" should be completed before this module is undertaken.

Module Goal:

At the completion of this module, the student will select and operate spraying and dusting equipment in a safe and efficient manner in spraying and dusting crops for insect, disease, pest or weed control.

Student Performance Objective 1:

Given a field (area) on a farm which represents a pest problem, the student will select and operate the appropriate tractor and equipment used for controlling weeds, insects and other pests so that when the student is confronted with selecting and operating farm equipment used for controlling weeds, insects and other pests, he/she will be proficient in operating the equipment in a safe and efficient manner by following directions in the appropriate operator's manual.

Instructional Areas:

1. Selecting the spraying or dusting application equipment

   a. Determining type of spray or dust to be applied
   b. Determining size of equipment most economical
   c. Considering the various types of equipment

      (1) Hydraulic sprayers
      (2) Hydro-pneumatic sprayers
      (3) Blowers
      (4) Aerosol generators - fogging equipment
      (5) Power dusters

2. Selecting the tractor to operate selected applicator

   a. Determining the horsepower required
   b. Determining wheel arrangement
   c. Determining hydraulic power requirements

3. Attaching chemical applicator to the tractor

   a. Trailer sprayers

      (1) Hitching equipment to the drawbar
      (2) Connecting hydraulic power
      (3) Connecting all hitchpoints

   b. Sprayer attached directly to tractor

      (1) Connecting all hitchpoints
      (2) Connecting hydraulic power

4. Observing all safety precautions in mixing chemicals

   a. Wearing appropriate clothing
   b. Following manufacturer's mixing directions
   c. Following label restrictions
   d. Washing thoroughly after mixing

5. Applying chemicals

   a. Broadcasting
   b. Banding
   c. Directing or shielding applications
   d. Locating on growing points
   e. Applying dormant applications
   f. Applying foliar applications
   g. Applying directly to the soil

6. Adjusting the chemical applicator
    a. Determining ground speed
    b. Determining pressure
    c. Determining nozzle size
    d. Leveling the equipment
    e. Adjusting the boon spring
    f. Adjusting nozzle height

7. Recording application rates and schedules
    a. Selecting the appropriate form
    b. Writing in information
    c. Filing records in appropriate place

Examples of Supporting References:

1. _Fundamentals of Service: Mowing and Spraying Equipment_. Moline, Illinois: John Deere Service Publication. 1971

2. _Insecticides_. The Ohio State University: Ohio Agricultural Education Curriculum Materials Service. 1973

3. _Weed Control-Cultural and Chemical_. The Ohio State University: Ohio Agricultural Education Curriculum Materials Service. 1969.

4. Service manuals and operator's instructions for equipment being used.

Examples of Student Learning Activities:

1. Given insecticide to be mixed for spraying on a field, the instructor may ask several students to come to class dressed appropriately for mixing the given insecticide.

2. Given a specific chemical application task, the instructor may ask several students to adjust the nozzle to the optimum height for even coverage.

Examples of Evaluation Techniques:

1. Given an insecticide label, the student will correctly identify the restrictions to follow in using the given insecticide.

2. Given a chemical application task completed with the information known, the student will correctly record the necessary information on the appropriate form with 100% accuracy.

Instructional Resources:

1. Access to a farm tractor
2. Access to a variety of chemical applicators
3. Chemical application
4. Access to a field for spraying or dusting
5. Equipment and containers for mixing chemicals
6. Chemical application records
7. Appropriate clothing and safety equipment for applying chemicals

Student Performance Objective 2:

Given access to a farm tractor and a chemical applicator which has been used to control pests or weeds, the student will clean, lubricate and store the tractor and chemical applicator by following recommendations in given service manual so that the equipment will operate safely and efficiently when again used to apply pest chemicals.

Instructional Areas:

1. Washing the tractor
    a. Using high pressure water hoses
    b. Using air pressure

2. Cleaning the chemical applicators
    a. For oil base chemicals, washing with water and a detergent
    b. For non-oil base spray, rinse with water
    c. Flush the tank with a solution of household ammonia or Trisodium Phosphate and water
        (1) 3 teaspoons of household ammonia per gallon of water
        (2) 2/3 fluid oz. Trisodium Phophate per gallon of water
    d. Allow chemical applicator to set for at least 12 hours
    e. Flush the chemical applicator with water after 12-24 hours

3. Lubricating and servicing the farm tractor

    a. This information has been covered in the module "Operating, Adjusting, Servicing and Storing Farm Tillage Equipment."

4. Lubricating and servicing chemical application equipment

    a. Lubricating all pressure type grease fittings
    b. Oiling moving parts
    c. Adjusting wheel bearings
    d. Checking tire inflation
    e. Tightening all bolts and screws
    f. Replacing worn or broken parts

5. Storing chemical applicators

    a. Flushing out
    b. Letting dry
    c. Disconnecting hoses
    d. Covering bare metal parts with oil
    e. Disassembling the nozzles and storing in oil
    f. Storing equipment in a dry location

6. Storing chemicals

    a. Cleaning out measuring containers
    b. Storing in original labeled containers
    c. Storing under lock and key
    d. Storing in a dry room, above freezing, away from feed, seed or fertilizer and out of reach of children

7. Disposing of chemical containers

    a. Making sure containers are completely empty
    b. Reading any special instructions of disposal on the label
    c. Break glass and punch holes in metal containers to avoid reuse
    d. Disposing through regular trash collections where possible or in a sanitary landfill
    e. Selecting disposal site away from home well, streams, livestock, or wildlife
    f. Burying at least 18 inches deep, deeper in sand
    g. Burning bags away from people areas
    h. Do not throw containers in garbage cans

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Prior to storing a chemical applicator, the instructor may ask several students to assist in flushing out the equipment with water and other appropriate materials.

2. Given an empty metal container that contained a poisonous agricultural chemical, the instructor may ask a student to crush the container for disposal.

Examples of Evaluation Techniques:

1. Given a poisonous chemical to store, the student will list at least four different concerns that must be considered in storing the chemicals.

2. Given a label of a poisonous agricultural chemical, the student will identify all the special instructions that must be observed with 100% accuracy.

Instructional Resources:

1. Access to water under pressure
2. Access to air under pressure
3. Detergent for cleaning oil base chemicals
4. Household ammonia or Trisodium Phosphate
5. Access to a chemical storage area
6. Label of an agricultural chemical
7. Used chemical container
8. Equipment to break or punch holes in and crush a chemical container made of metal
9. Access to an area for burning bags containing agricultural chemicals

SERVICING, STARTING AND DRIVING SELF-PROPELLED COMBINES

CODE--01.0301

Module Concept:

The modern self-propelled combine can harvest any of the seed crops. It is an expensive item of farm equipment and proper operation is important to the farmer. With the large investment in raising grain crops it is also very important to harvest as much of the grain as possible. Poor [illegible] of the self-propelled combine can increase [illegible] losses of grain.

This module will depict for the instructor areas which should be taught relative to operating a self-propelled combine to enable the student to operate a self-propelled combine safely and economically.

Prerequisites:

The module "Understanding Farm Safety and Using Safety Precautions in Operating Farm Tractors and Equipment" should be completed before this module is undertaken.

Module Goal:

At the completion of this module, the student will operate a self-propelled combine in a safe and efficient manner.

Student Performance Objective 1:

Given access to a self-propelled combine without harvesting attachments, the student will operate a self-propelled combine without attachments so that when the student is confronted with operating a self-propelled combine, he/she will be proficient in operating the equipment in a safe manner by following directions in the appropriate operator's manual.

Instructional Areas:

1. Identifying and explaining functions of self-propelled combine without harvesting equipment
    a. Engine and drives
    b. Transmission
    c. Hydraulic system
    d. Instruments
2. Servicing the unit
    a. Checking the fuel
    b. Checking the oil
    c. Checking the battery
    d. Checking the radiator

3. Starting the engine
    a. Providing adequate ventilation if inside
    b. Starting from operator's platform
    c. Disengaging PTO before starting
    d. Shifting to neutral or park before starting
    e. Engaging the starter

4. Starting the forward movement
    a. Looking ahead and to the rear
    b. Engaging power to drive wheels slowly

5. Driving the equipment forward
    a. Changing gears
    b. Adjusting throttle

6. Stopping the forward movement of the equipment
    a. Signaling before stopping
    b. Slowing down
    c. Pumping brakes when stopping on slippery surfaces
    d. Shifting to park after stopping
    e. Turning off electrical switches

7. Backing-up the equipment
    a. Starting the engine
    b. Looking ahead and to the rear
    c. Engaging the power to drive wheels slowly

Examples of Supporting References:

1. Tractors, Fundamentals of Machine Operation. Moline, Illinois: John Deere Service Publications.

2. Manufacturer's Operator's Manual

Examples of Student Learning Activities:

1. Given a self-propelled combine, the instructor may ask a student to demonstrate the changing of gears while the equipment is stopped.

2. Given a self-propelled combine, the instructor may ask a student to identify the PTO unit and point out to the class which lever controls the PTO unit.

Examples of Evaluation Techniques:

1. Given a self-propelled combine without attachments, the student will start the engine of the combine, move the implement approximately 20 feet forward, and stop the machine safely and smoothly.

2. Given a self-propelled combine, the student will check the fuel supply and add the appropriate fuel to fill the tank without spilling any fuel on the ground or equipment.

Instructional Resources:

1. Access to a self-propelled combine without attachments
2. Fuel to be added to the equipment
3. Access to a large outdoor area in which to drive the self-propelled combine

Student Performance Objective 2:

Given access to a self-propelled combine with harvesting attachments, the student will operate a self-propelled combine with harvesting attachements by following recommendations in the appropriate service manual.

Instructional Areas:

1. Connecting harvesting attachment to self-propelled combine

    a. Driving combine power unit to harvesting equipment
    b. Connecting all hitchpoints
    c. Connecting hydraulic system

2. Disconnecting harvesting attachment from self-propelled combine

    a. Disconnecting all hitchpoints
    b. Disconnecting hydraulic system
    c. Driving tractor away from harvesting attachment

3. Operating forward movement of the combine

    a. Starting the combine

        (1) Disengaging the PTO
        (2) Shifting to neutral or park
        (3) Engaging the starter

    b. Starting the forward movement

        (1) Looking ahead and to the rear
        (2) Engaging the power drive wheels slowly

    - (3) Driving to the field
    - (4) Engaging the harvesting equipment
    - (5) Driving at the appropriate speed

  - c. Stopping the forward movement

    - (1) Disengaging the harvesting equipment
    - (2) Signaling before braking
    - (3) Slowing down before braking
    - (4) Braking to a full stop
    - (5) Shifting to park or neutral
    - (6) Lowering equipment
    - (7) Turning off electrical switches

4. Backing-up the self-propelled combine

  - a. Looking ahead and to the rear
  - b. Disengaging the PTO
  - c. Shifting to neutral or park
  - d. Engaging the starter
  - e. Lifting the harvesting equipment where appropriate
  - f. Shifting to reverse
  - g. Engaging the power drive wheels slowly
  - h. Braking the combine to a stop
  - i. Shifting to neutral or park
  - j. Lowering harvesting equipment
  - k. Turning off electrical switches

Examples of Supporting References:

Supporting references were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a self-propelled combine with harvesting attachment connected, the instructor may ask several students to help in disconnecting the harvesting attachment from the power unit.

2. Given a self-propelled combine with harvesting attachment connected, the instructor may ask several students to start the combine, drive it 10 feet and stop it.

Examples of Evaluation Techniques:

1. Given a self-propelled combine power unit and a harvesting attachment the student will connect all of the hitchpoints correctly.

2. Given an attached harvesting attachment on a self-propelled combine, the student will start the power unit and back the equipment up for 10 feet in a safe manner.

Instructional Resources:

1. Access to a self-propelled combine and a harvesting attachment
2. Equipment to attach and disconnect the harvesting atttachment from the power unit

OPERATING, ADJUSTING, SERVICING AND STORING SELF-PROPELLED COMBINES

CODE--01.0301

Module Concept: The modern self-propelled combine is an expensive item of farm equipment that can harvest any of the common farm seed crops. Because of the large investment involved, it is important to the owner and or operator of such equipment to adjust the machinery in such a way as to achieve maximum efficiency with the minimum field losses. It is also important to service and store the self-propelled combine in such a way that the life of the equipment is prolonged.

Prerequisites: The modules "Understanding Farm Safety and Using Safety Precautions in Operating Farm Tractors and Equipment" and " Servicing, Starting and Driving Self-Propelled Combines" should be completed before this module is undertaken.

Module Goal: At the completion of this module, the student will be able to operate, adjust, service and store a self-propelled combine in a safe, efficient and economical manner.

Student Performance Objective 1: Given access to a self-propelled combine and the responsibility of harvesting various types of grain crops, the student will operate and adjust a self-propelled combine so that when the student is confronted with operating and adjusting a self-propelled combine, he/she will be proficient in operating and adjusting the self-propelled combine by following directions in the appropriate operator's manual.

Instructional Areas:

1. Selecting and attaching header
    a. Width of cut
    b. Type of crop to be combined
    c. Driving power unit to header
    d. Connecting hitch points
    e. Connecting hydraulic system

2. Operating the self-propelled combine
    - a. Starting the combine
    - b. Driving to the field
    - c. Engaging the harvesting attachment
    - d. Driving at the appropriate speed
    - e. Observing all safety precautions
    - f. Measuring harvesting losses
        - (1) Knowing where losses commonly occur
        - (2) Determining why losses occur
        - (3) Determining what losses are reasonable

3. Adjusting various parts of the self-propelled combine
    - a. Checking and adjusting machine speed
        - (1) Using a speed indicator
        - (2) Adjusting pulleys
        - (3) Changing sprockets
    - b. Adjusting the cylinder concave clearance and cylinder speed
        - (1) Determining results of increasing clearance and speed
        - (2) Determining results of decreasing clearance and speed
    - c. Adjusting cutter bar height
        - (1) Mechanical adjustments
        - (2) Automatic height controls
    - d. Adjusting the reel
        - (1) Changing the reel speed
        - (2) Changing the reel height
    - e. Determining forward speed
    - f. Adjusting the cleaning sieves and fan blast
        - (1) Chaffer opening adjustment
        - (2) Chaffer height adjustment
        - (3) Chaffer extension opening adjustment
        - (4) Chaffer extension height adjustment
        - (5) Shoe sieve opening adjustment
        - (6) Shoe sieve height adjustment
        - (7) Special shoe sieve

g. Determining type of shoe sieve
h. Adjusting cleaning fan
i. Adjusting force of cleaning fan air blast
j. Changing direction of cleaning fan air blast
k. Raising or lowering tailboard

Examples of Supporting References:

1. Combines and Combining. The Ohio State University: Ohio. The Ohio Agricultural Education Curriculum Materials Service. 1970.

2. Service manuals and operator's instructions for equipment being used.

Examples of Student Learning Activities:

1. Given a self-propelled combine, the instructor may ask several students to drive the combine once around the field while combining.

2. Given a self-propelled combine stopped in the middle of a field while harvesting, the instructor may ask several students to demonstrate the procedure to follow in making a kernel count in estimating harvesting losses.

Examples of Evaluation Techniques:

1. Given an operating self-propelled combine and a speed indicator, the student will measure the machine speed off the "key" shaft within 1% accuracy.

2. Given a corn field after combining, the student will lay out a 1/100 acre area and gather the missed ears and determine the total ear loss with 90% accuracy.

Instructional Resources:

1. Access to an operational self-propelled combine
2. At least two types of headers
3. Tools for attaching headers to the power unit
4. A field to be combined
5. Tools for adjusting the combine
6. A measuring tape
7. A speed indicator

Student Performance Objective 2:

Given access to a self-propelled combine that has been used to harvest grain crops, the student will lubricate, clean and store the self-propelled combine by following recommendations in appropriate service manual so that the equipment will operate safely and efficiently when again used to harvest grain crops.

Instructional Areas:

1. Lubricating the self-propelled combine harvesting attachment
    a. Lubricating grease pressure fittings
    b. Lubricating bearings
    c. Lubricating chains
2. Servicing the self-propelled combine harvesting attachment
    a. Adjusting and changing belts
    b. Adjusting chain tension
    c. Aligning chain and sprocket
    d. Installing chains
    e. Cleaning chains
    f. Adjusting gears
    g. Keeping bolts and nuts tight
3. Cleaning the self-propelled combine
    a. Removing panels to reach accumulated dirt
    b. Using tools to remove grease and dirt
    c. Applying solvents on areas that require cleaning
    d. Removing mud and stalks from exterior
    e. Wiping machine dry
    f. Replacing panels
4. Storing the self-propelled combine
    a. Cleaning the exterior of the machine
    b. Performing an engine tune-up
    c. Draining and refilling transmission oil
    d. Adding rust inhibitor to oil as recommended
    e. Cleaning and repacking wheel bearings
    f. Draining and refilling hydraulic system
    g. Adding rust inhibitor to hydraulic fluid as recommended
    h. Parking the machine in a storage area
    i. Draining the fuel tank
    j. Removing, cleaning and replacing fuel sediment bowl and filters
    k. Adding two gallons of fuel to the tank with rust inhibitor if recommended
    l. Running the engine for several minutes and draining tank

m. Draining fuel lines
n. Covering ends of air inlet pipe, exhaust pipe, crankcase breather pipe and hydraulic system pipe
o. Removing battery
p. Removing weights from machine
q. Removing tires or raising machine so tires are off the ground
r. Releasing all drive belts and chains
s. Oiling all chains with rust preventive
t. Coating all exposed metal surfaces that tend to rust with rust preventive
u. Lubricating all lubrication points
v. Making list of repairs required
w. Painting areas that require painting
x. Covering machine with canvas if not inside
y. Making repairs as listed before the next season

Examples of Supporting References:

In addition to Supporting References listed in Student Performance Objective 1, the following may be helpful.

1. Fundamentals of Machine Operation-Preventive Maintenance. Moline, Illinois: John Deere Service Publications. 1973.

Examples of Student Learning Activities:

1. Given a self-propelled combine with a broken chain in the harvesting attachment, the instructor may ask several students to install a new chain.

2. Given a self-propelled combine, the instructor may ask several students to use a wrench and screw driver in checking all the bolts and nuts for tightness.

Examples of Evaluation Techniques:

1. Given a self-propelled combine with chain drives, the student will adjust a chain drive in such a way that the chain sag is 1/4 inch per foot between shaft centers with one side of the chain taut, with 90% accuracy.

2. Given a self-propelled combine service manual, the student will correctly determine the recommendations for the addition of rust inhibitor to at least three vital fluids.

Instructional Resources:

1. Access to a self-propelled combine
2. Grease gun and appropriate grease
3. Oil and appropriate oil container
4. Tools for adjusting belts and pulleys
5. Ruler
6. Cloths for cleaning and drying machinery
7. Equipment for raising the machine
8. Paint and paint supplies
9. Canvas where required

OPERATING FARM TRUCKS IN TRANSPORTING AGRICULTURAL MACHINERY AND COMMODITIES

CODE--01.0301

Module Concept:

The Farm Equipment Operator is hired to operate agricultural equipment on the farm. The operation of agricultural equipment must be done safely, efficiently and economically. Farm trucks are used to transport agricultural machinery and commodities. The Farm Equipment Operator must be able to operate the farm truck in a safe and efficient manner.

The purpose of this module is to depict for the instructor areas which should be taught relative to safely operating and servicing farm trucks to enable the student to effectively, safely and efficiently operate a farm truck.

Prerequisities:

The student must possess a vaild driver's license in the state in which the training is taken.

Module Goal:

At the completion of this module, the student will be able to drive, service, load and unload a farm turck safely and efficiently.

Student Performance Objective 1:

Given access to various types of farm trucks, the student will service, start and drive a farm truck so that when the student is given the task of servicing and driving the truck he/she is capable of doing so by following directions in the appropriate operator's manual.

Instructional Areas:

1. Identifying and explaining the functions of various truck controls
    a. Steering controls
    b. Clutching controls
    c. Braking mechanism
    d. Lighting system
    e. Windshield wiper
2. Identifying and explaining the functions of various instruments
    a. Fuel level gauge
    b. Engine oil pressure light
    c. Engine water temperature light
    d. Generator light
    e. Engine RPM gauge
3. Performing preoperational check

a. Checking fuel
b. Checking oil
c. Checking battery water level
d. Checking radiator water level
e. Inspecting tires visually

4. Starting the engine

a. Shifting to neutral or park
b. Engaging the starter

5. Driving a truck forward

a. Looking ahead and to the rear
b. Using clutch where applicable
c. Shifting to first gear or drive
d. Letting out clutch slowly
e. Signaling before turning
f. Slowing down before braking
g. Stopping the truck

(1) Pumping brakes when on slippery surface
(2) Shifting to park
(3) Setting parking brake
(4) Turning off engine

6. Backing-up a truck

a. Looking ahead an to the rear
b. Using clutch where applicable
c. Shifting into reverse
d. Letting out clutch slowly
e. Stopping the truck

Examples of Supporting References:

1. Manufacturer's operator's manual of the truck to be driven

2. State Vehicle Operator's Manual

Examples of Student Learning Activities:

1. During a rainy day, the instructor may ask a student to demonstrate how to turn on the windshield wiper of a given truck.

2. While driving a farm truck forward, the instructor may ask a student to demonstrate how to slow the truck down on a slippery surface.

Examples of Evaluation Techniques:

1. Given a farm truck, the student will identify the gauges on the instrument panel with 90% accuracy

2. Given a farm truck, the student will get behind the steering wheel and start the truck according to directions in the operator's manual.

Instructional Resources:

1. Access to several types of farm trucks
2. Chart of the truck instrument panel
3. Cloth for wiping off oil dip stick

Student Performance Objective 2:

Given access to a farm truck and the responsibility of transporting agricultural equipment to a designated site, the student will hitch equipment to, load, tow and unload farm trucks without injurying human bodies or damage to farm trucks, machinery, motor vehicles, or other objects.

Instructional Areas:

1. Hitching farm equipment to a truck
    - a. Backing up truck to equipment
    - b. Hitching with standard hitch
    - c. Attaching chains to hold equipment in place
2. Loading farm equipment on a farm truck or wagon
    - a. Using a ramp
    - b. Using a loading dock
    - c. Lifting small equipment by hand onto wagon
        - (1) Lifting without bending back
        - (2) Wearing protective clothing
    - d. Attaching safety chains and ropes
    - e. Using blocking material for wheels
3. Towing agricultural equipment with a truck
    - a. Hitching equipment to the truck
    - b. Attaching safety signs
    - c. Observing all safety precautions in towing
    - d. Observing highway regulations in towing
    - e. Towing the machinery
4. Unloading farm machinery from a truck or wagon
    - a. Using a loading ramp
    - b. Using a loading dock
    - c. Lifting small equipment by hand
        - (1) Lifting without bending back
        - (2) Wearing protective clothing

Examples of Supporting References:

1. Operator's manual for the truck used
2. Fundamentals of Machine Operation - Agricultural Machine Safety. Moline, Illinois: John Deere and Company. 1974.

Examples of Student Learning Activities:

1. Given a farm truck and a farm wagon with a compatable hitch, the instructor may ask several students to back the truck up to the wagon and hitch the wagon to the truck.
2. Given a large box on a loading platform and a truck, the instructor may ask four students to load the box on the truck.

Examples of Evaluation Techniques:

1. Given a wagon to be towed by a farm truck, the student will attach safety signs as required by state law.
2. Given a cardboard box, the student will demonstrate the proper technique of lifting according to instructions in Fundamentals of Machine Operation-Agricultural Machinery Safety.

Instructional Resources:

1. Access to a farm truck with hitch
2. Access to a farm wagon with a hitch to match that on the available farm truck
3. Access to a loading dock
4. Access to a ramp
5. Large cardboard box
6. Highway safety signs to attach to wagons

Student Performance Objective 3:

Given the responsibility of transporting agricultural commodities to designated site, the student will mechanically or manually load farm commodities on, weigh, transport, unload commodities and clean the truck without injury to human bodies or damage to the farm equipment.

Instructional Areas:

1. Visually checking the condition of a truck
    a. Inspecting for oil or water leakage

   - b. Inspecting the battery for corrosion, cracked case or leaks
   - c. Inspecting battery cables and connections for looseness
   - d. Inspecting distributor for cracked cap or other damage
   - e. Inspecting cooling system for leaks, deteriorated hoses, bent radiator fins or slipping fan belts
   - f. Inspecting fuel system for leaks or dented lines
   - g. Inspecting condition of tires

2. Loading a truck
   - a. Manually loading
   - b. Mechanically loading

3. Weighing a truck with load
   - a. Driving truck onto scales
   - b. Releasing the scales for weighing
   - c. Reading the weight

4. Operating a loaded farm truck
   - a. Observing all highway regulations
   - b. Driving the truck

5. Unloading a farm truck
   - a. Manually
   - b. Mechanically

6. Cleaning the farm truck
   - a. Washing
   - b. Steam cleaning
   - c. Sweeping out farm crops

7. Storing the farm truck
   - a. Cleaning the truck
   - b. Parking in selected storage area
   - c. Following service manual for given truck

Examples of Supporting References:

1. Operator's and service manuals for given truck
2. Highway regulations for given state in which truck is operated

Examples of Student Learning Activities:

1. Given a farm truck, the instructor may ask two students to make a visual inspection of the truck battery and report to the class the battery condition.
2. Given a farm truck that has been operated on a muddy road, the instructor may ask several students to wash the truck.

Examples of Evaluation Techniques:

1. Given a truck and a scale, the student will weigh the truck to within ±10 pounds of the correct weight.
2. Given a farm truck with a defective radiator hose, during a visual inspection of the truck the student will correctly identify the defect.

Instructional Resources:

1. Access to a farm truck
2. Access to a farm commodity that can be moved in the farm truck available
3. Access to a truck scale
4. Access to an area where the truck can be washed
5. Soap, water and cloths for washing a farm truck

SELECTING AND OPERATING HAY AND FORAGE EQUIPMENT

CODE--01.0301

Module Concept:

When it come time for the Farm Equipment Operator to harvest the hay or forage crop, the harvesting equipment becomes very important. Since the weather is an important factor to harvest the highest quality of hay or forage, the harvesting equipment must be operated efficiently.

The purpose of this module is to depict for the instructor areas which should be taught relative to operating hay and forage equipment safely, efficiently and economically.

Prerequisities:

The module "Understanding Farm Safety and Using Safety Precautions in Operating Farm Tractors and Equipment" should be completed before this module is undertaken.

Module Goal:

At the completion of this module, the student will operate hay and forage equipment in a safe an efficient manner in harvesting hay and forage crops.

Student Performance Objective 1:

Given the type of crop and number of acres to be harvested and access to various types of hay and forage equipment, the student will select, attach, operate and adjust hay and forage equipment as recommended by given operator's manual so that the maxium amount of hay and forage can be harvested with minimum damage.

Instructional Areas:

1. Identifying hay and forage equipment
    a. Determining ways mowers cut
        (1) Cutter-bar mower
        (2) Rotary mower
        (3) Mower-conditioners
    b. Explaining operating principles of various hay and forage equipment
2. Selecting the type of equipment for a given crop
    a. Cutter-bar mower
    b. Seld-propelled cutter-bar windrowers
    c. Mower-conditioners
    d. Flail mower-conditioners
    e. Rotary cutters

3. Selecting a tractor to operate hay or forage equipment

    a. Side-mounted equipment
    b. Rear-mounted equipment
    c. Semi-mounted equipment
    d. Trail or pull-type equipment

4. Attaching hay or forage equipment to the tractor

    a. Hitching standard drawbar
    b. Making a 3-point hitch
    c. Making a 2-point hitch
    d. Making a single-point hitch

5. Operating various hay and forage equipment safely

    a. Studying operator's manual
    b. Wearing close-fitting clothing
    c. Following safe operating procedures

        (1) Never stand behind discharge spout while harvester is operating
        (2) Always turn equipment off to clean, oil or adjust
        (3) Always completely stop equipment before hooking up wagons
        (4) Disengaging power while not harvesting
        (5) Do not open doors or shields while equipment is operating

    d. Studying field

        (1) Removing foreign objects from the field
        (2) Locating ditches
        (3) Planning harvesting operations
        (4) Spacing wheels far apart on steep slopes

    e. Starting the equipment
    f. Operating the Power Take-off
    g. Raising and lowering cutter bar
    h. Driving equipment forward
    i. Backing-up
    j. Shutting off engine and applying parking brake
    k. Pulling trash build-up away from cutter bars
    l. Determining speed of operation
    m. Easing equipment into standing hay or forage and operating equipment

6. Adjusting hay or forage harvesting equipment
    a. Knife mechanisms
    b. Guards
    c. Power Take-off shafts
    d. Drive shafts
    e. Safety mechanisms
    f. V-belts and pulleys
    g. Roller chains and sprockets
    h. Gear drives

Examples of Supporting References:

1. Selecting and Maintaining Field Mowers. Athens, Georgia: American Association for Agricultural Engineering and Vocational Agriculture. 1966.
2. Fundamentals of Machine Operation - Agricultural Machinery Safety. Moline, Illinois: John Deere Service Publications. 1974.

Examples of Student Learning Activities:

1. Given a specific hay crop to harvest, the instructor may ask several students to report on the most appropriate equipment to harvest the hay crop.
2. Given a field mower out in a field which is plugged up with hay or trash, after the mower is completely stopped, the instructor may have two students clean the trash from the mower.

Examples of Evaluation Techniques:

1. Given a hay or forage harvesting operation, the student will demonstrate five safe operating procedures to keep in mind while operating the equipment.
2. Given a field of hay to be cut, the student will study the field and correctly identify the direction of travel for the steep slopes.

Instructional Resources:

1. Access to various types of hay and forage harvesting equipment
2. Operator's manual for each piece of equipment
3. Appropriate close-fitting clothing
4. Access to a field of hay or forage to be harvested
5. Tools for adjusting the harvesting equipment

Student Performance Objective 2:

Given access to hay and forage machinery that has been used on the farm, the student will lubricate, clean and store hay and forage equipment by following recommendations in the appropriate service manuals so that the machinery will operate safely and efficiently when again used to harvest the forage and hay.

Instructional Areas:

1. Lubricating and servicing hay and forage harvesting equipment

   a. Disengaging power and stopping machine
   b. Supporting equipment on blocks or stands as required
   c. Following all recommendations of service manuals in lubricating and servicing equipment:

      (1) Lubricating all pressure-type grease fittings
      (2) Oiling all moving parts
      (3) Adjusting wheel bearings
      (4) Checking tire inflation
      (5) Tightening all bolts and screws
      (6) Replacing all worn parts

   d. Using containers to store removed parts
   e. Providing adequate ventilation while working inside
   f. Protecting self from sharp edges and protruding parts
   g. Cleaning up spilled oil, grease and fuel
   h. Working as a team
   i. Doing the job correctly

2. Cleaning various hay and forage harvesting equipment

   a. Removing all hay or forage from the equipment
   b. Scraping off all dirt
   c. Using solvent to clean grease and dirt that otherwise will not come off

3. Storing various pieces of hay and forage harvesting equipment

   a. Cleaning exterior of machine
   b. Cleaning and repacking wheel bearings

c. Parking machine in selected storage location
d. Removing tires if machine is not to be supported off the ground, otherwise place supports under the machinery
e. Releasing tension on all drive belts and chains
f. Applying grease or rust preventive to chains
g. Coating all exposed metal surfaces with grease or rust preventive
h. Lubricating all points normally requiring lubrication
i. Checking machine carefully and making list of parts or repairs needed to make the machine ready for operation
j. Cleaning off rust and painting areas where appropriate
k. Covering machine with canvas if not stored inside building

Examples of Supporting References:

Supporting References were listed in Student Performance Objective 1.

Examples of Student Learning Activities:

1. Given a hay harvesting machine, the instructor may ask several students to clean all the hay from the machine.

2. Given a forage harvesting machine to be stored for the winter, the instructor may ask several students to apply a rust preventive to the chains.

Examples of Evaluation Techniques:

1. Given a hay harvesting machine, the student will lubricate all the pressure-type fittings by following the recommendations of the service manual.

2. Given a forage harvesting machine, the student will release all drive belts and chains prior to storing the equipment by following the recommendations of the service manual.

Instructional Resources:

1. Access to a variety of hay and forage harvesting equipment
2. Blocks or stands to support the equipment
3. Jacks to lift the equipment
4. Appropriate oil
5. Grease gun and appropriate lubricant
6. Tools for tightening bolts and screws
7. Materials for cleaning up oil and grease

SELECTING AND OPERATING VARIOUS TYPES OF MACHINERY USED FOR HANDLING MATERIALS ON THE FARM

CODE--01.0301

Module Concept: With increased agricultural production on the modern farm, there is an increasing use of mechanization in handling and moving materials on the farm. Materials handling equipment must be operated safely and efficiently to prevent accidents and complete the jobs necessary without undue delay.

The purpose of this module is to depict for the instructor areas which should be taught relative to operating materials handling equipment on the farm which will enable the student to effectively and safely operate such equipment in moving farm supplies and produce.

Prerequisites: The module "Understanding Farm Safety and Using Safety Precautions in Operating Farm Tractors and Equipment" should be completed before this module is undertaken.

Module Goal: At the completion of this module, the student will be able to safely and efficiently operate various common types of machinery used for handling materials on the farm.

Student Performance Objective 1: Given the type and quantity of materials to remove from a location on the farm, the student will select, attach, operate and adjust machinery used for handling materials on the farm as recommended by the appropriate operator's manual and so that farm materials can be removed safely and efficiently.

Instructional Areas:

1. Identifying common types of materials handling equipment and explaining their operating principles
    - a. Front-end loaders
    - b. Forklifts
    - c. Manure spreaders
    - d. Grain bins
    - e. Portable elevators and augers
    - f. Farm wagon
    - g. Silo unloaders
    - h. Crop driers
    - i. Grinder mixers

2. Determining various uses of common types of materials handling equipment

3. Attaching various types of materials handling equipment to power unit

4. Operating common types of materials handling equipment safely

    a. Front-end loaders

        (1) Keeping bucket low while carrying loads
        (2) Traveling slowly
        (3) Using recommended ballast
        (4) Loading bucket evenly
        (5) Never attaching tow chain to loader
        (6) Removing loader when not in use

    b. Forklifts

        (1) Using head guards and load backrests
        (2) Observing equipment's maximum load capacity
        (3) Balancing load on the forks
        (4) Using care when moving loads
        (5) Raising only enough to move safely
        (6) Allowing rear-end swing while turning
        (7) Avoid sudden starts, stops and changes in speed
        (8) Providing adequate ventilation
        (9) When parking, lowering forks and shutting off engine

    c. Manure spreaders

        (1) Keeping solid objects out of the spreader
        (2) Loosening flails and chains before loading
        (3) Keeping chains and beaters in good working order
        (4) Parking equipment with brakes set
        (5) Disengaging PTO before working around spreader

(6) Flushing tank in liquid spreaders
(7) Checking relief valve on liquid spreaders

d. Grain bins

(1) Breaking up grain bridges
(2) Entering grain bin only after equipment is off
(3) Installing ladders in all bins
(4) Entering bins only while observing all necessary safety precautions
(5) Using filter respirators

e. Portable elevators and augers

(1) Noting all moving parts where danger can occur
(2) Wearing appropriate clothing
(3) Using all guards and covers as recommended
(4) Operating equipment at a safe speed
(5) Transporting portable elevators with caution
(6) Checking cables regularly

f. Farm wagons

(1) Using safety locking drawpin
(2) Loading evenly
(3) Knowing load limits
(4) Using care in towing heavy loads
(5) Staying away from ditches and steep banks
(6) Disengaging power before unclogging
(7) Maintaining wagons
(8) Unloading self-unloading wagons on level surface
(9) Keeping children away from unloading operations

g. Silo unloaders

(1) Raising unloaders to the top with two persons
(2) Removing fuses before starting work
(3) Locking main switch
(4) Using only manual reset circuit protection
(5) Providing fresh air before entering silo

h. Crop driers

(1) Reducing fire hazards
(2) Keeping fuel storage tanks a safe distance away
(3) Using recommended guards and shields
(4) Making preoperational checks

i. Grinder-mixers
    (1) Using safe PTO procedures
    (2) Stopping hammermills completely before removing cover
    (3) Keeping all shields in place
    (4) Using a push stick

5. Adjusting common materials handling equipment
    a. Using operator's manual for given equipment
    b. Selecting appropriate tools

Examples of Supporting References:

1. Fundamentals of Machine Operation - Agricultural Machinery Safety. Moline, Illinois: John Deere and Company. 1974.

2. Operator's manual for each item of materials handling equipment worked on.

Examples of Student Learning Activities:

1. Given a task of moving a load commonly moved with a front-end loader, and a tractor with attached front-end loader, the instructor may ask several students in turn to start the tractor and demonstrate a safe method of loading the front-end loader.

2. Given an operator's manual for a portable elevator, the tools to adjust and access to a portable elevator, the instructor may ask several students to inspect the cables and cable clamps of the elevator.

Examples of Evaluation Techniques:

1. Given a front-end loader attached to a tractor, the student should be able to operate the tractor and front-end loader and point out at least six precautions to take while operating the same.

2. Given a specific materials handling task, the student should be able to select an efficient and safe method of moving the materials to a given location.

Instructional Resources:

1. Access to the following

Front-end loader
Forklift
Manure spreader

grain bins
portable elevators
auger
farm wagon
silo unloader

2. Operator's manuals for each of the above
3. Tools for adjusting each of the above
4. Sample materials to be moved

Student Performance Objective 2:

Given access to various types of materials handling machinery that has been used on the farm, the student will lubricate, clean and store materials handling equipment by following recommendations in the appropriate service manuals so that the machinery will operate safely and effectively when again used to remove materials.

Instructional Areas.

1. Lubricating and servicing materials handling equipment
    a. Disengaging power and stopping the equipment
    b. Following all recommendations of service manuals
        (1) Lubricating all pressure-type grease fittings
        (2) Oiling all moving parts
        (3) Adjusting wheel bearings
        (4) Checking tire inflation
        (5) Tightening all bolts and screws
        (6) Replacing all worn parts
        (7) Checking all chains, cables, and belts
    c. Using containers to store removed parts
    d. Providing adequate ventilation while working
    e. Protecting self from sharp edges and protruding parts
    f. Cleaning up spilled oil, grease and fuel
2. Cleaning common materials handling equipment

   a. Removing all materials from equipment
   b. Scraping off all dirt
   c. Using solvent to clean grease and dirt that otherwise will not come off

3. Storing common materials handling equipment

   a. Cleaning exterior of machine
   b. Cleaning and repacking wheel bearings
   c. Parking equipment in selected storage location
   d. Removing tires if machine is not supported
   e. Releasing tension on all drive belts and chains
   f. Applying grease or rust preventive to chains
   g. Coating all exposed metal surfaces with grease or rust preventive
   h. Lubricating all points normally requiring lubrication
   i. Checking equipment carefully and making list of parts or repairs needed
   j. Cleaning off rust and painting areas where appropriate
   k. Covering machine with canvas if not stored inside a building

Examples of Supporting References:

In addition to supporting references listed in Student Performance Objective 1, the following may be helpful:

1. Fundamentals of Machine Operation - Preventive Maintenance. Moline, Illinois: John Deere Company. 1973.

Examples of Student Learning Activities:

1. Given a manure spreader in the winter, the instructor may ask two students to use a pry bar to loosen a frozen chain.

2. Given an appropriate grease gun with grease, the instructor may ask several students to use the grease to lubricate all pressure type grease fittings on a given materials handling machine.

Examples of Evaluation Techniques:

1. Given a tire and tire gauge, the student will measure the tire pressure within two pounds of the actual pressure.

2. Given an item of materials handling equipment and an appropriate size canvas, the student will cover the machine with the canvas in such a way that the canvas will not blow away in a strong wind and rain will not fall on the protected parts of the machine.

Instructional Resources:

1. Access to various common materials handling equipment
2. Service manuals for each of the available machines
3. Grease gun and appropriate grease
4. Tools for tightening bolts and screws
5. Protective clothing and gloves
6. Solvent to clean off grease
7. Rope and canvas enough to cover one piece of materials handling equipment
8. Tire gauge
9. Rust preventive and grease

SELECTING AND OPERATING VARIOUS TYPES OF FARM MAINTENANCE EQUIPMENT

CODE--01.0301

Module Concept:

There are a number of labor-saving devices that can be used on the farm for general use and farm maintenance operations. The operation of such equipment can save the farmer time and help the farm operation become more efficient. The use of some of the equipment is on an occasional basis and it is very important to consider the safety precautions necessary to operate such equipment because one tends to forget necessary precautions with the passing of time when not using the equipment frequently.

The purpose of this module is to depict for the instructor areas which should be taught relative to operating various types of farm labor-saving and/or maintenance equipment to enable the student to effectively and safely operate such equipment around the farm.

Prerequisites:

The module "Understanding Farm Safety and Using Safety Precautions in Operating Farm Tractors and Equipment" should be completed before this module is undertaken.

Module Goal:

At the completion of this module, the student will be able to safely and effectively operate various types of maintenance equipment on the farm.

Student Performance Objective 1:

Given the type of farm maintenance task to be performed and access to various types of farm maintenance equipment, the student will select, attach, operate and adjust farm maintenance equipment as recommended in the appropriate operator's manual and so that the maintenance operation on the farm is performed safely and at maximum efficiency.

Instructional Areas:

1. Identifying common types of farm maintenance equipment and explaining their operating principles
   - a. Rotary-type mowers
   - b. Posthole diggers
   - c. Post drivers
   - d. Chain saws
   - e. Lawn and garden tractors

2. Determining various uses of common types of maintenance machinery and power requirements

3. Attaching common types of farm maintenance equipment to appropriate farm tractor

    a. Rotary type mowers
    b. Posthole diggers
    c. Post drivers

4. Operating common types of farm maintenance equipment safely

    a. Rotary-type mowers

        (1) Watching for objects that can be thrown
        (2) Keeping away from working area
        (3) Disengaging PTO before starting tractor
        (4) Disengaging PTO and shutting off tractor and setting brakes before getting off tractor to investigate for any reason
        (5) Using care in turning sharp corners
        (6) Setting tires wide and mowing with mower level
        (7) Using mowers only for designed purposes
        (8) Operating by following directions in operator's manual

    b. Posthole diggers

        (1) Shifting transmission into park or neutral
        (2) Setting tractor brakes before digging
        (3) Running digger slowly
        (4) Digging hole in small steps
        (5) Removing lodged augers

    c. Post drivers

        (1) Following directions in operator's manual
        (2) Shutting off engine and lowering hammer to lowest level before adjusting
        (3) Keeping hands out of space between top of post and hammer and away from posts being driven
        (4) Using proper design speed
        (5) Using a safety fork
        (6) Using all safety shields
        (7) Storing with hammer in lowered position

    d. Chain saws

        (1) Starting the chain saw
        (2) Making a few trial cuts on small logs supported off the ground

    - (3) Felling trees
    - (4) Limbing trees
    - (5) Bucking trees
    - (6) Timming

  - e. Lawn and garden tractors

    - (1) Starting the lawn tractor
    - (2) Operating the lawn tractor
    - (3) Avoiding upsets
    - (4) Attaching equipment
    - (5) Operating with attachments

5. Adjusting various types of farm maintenance equipment

  - a. Stopping equipment
  - b. Using service manual
  - c. Selecting appropriate tools
  - d. Making adjustments as recommended

Examples of Supporting References:

1. Fundamentals of Machine Operation - Agricultural Machinery Safety. Moline, Illinois: John Deere and Company. 1974.

2. Operator's manual for each given piece of equipment to be operated.

Examples of Student Learning Activities:

1. Given a garden tractor with attached mower, the instructor may ask several students to start the tractor, and while observing all safety precautions, mow a portion of a lawn.

2. Given a chain saw, the instructor may ask several students to demonstrate a safe method of starting the chain saw.

Examples of Evaluation Techniques:

1. Given a posthole digger, the student will correctly identify the shear pin and explain its use.

2. Given a rotary-type mower and its operator's manual, the student will correctly list the uses of the equipment.

Instructional Resources:

1. Access to the following equipment:
    a. Rotary-type mower
    b. Posthole digger
    c. Post driver
    d. Chain saw
    e. Garden tractor
    f. Tractor to operate a,b, and c
2. Operator's manual for each of the above items of equipment
3. Tools for adjusting the above items of equipment

Student Performance Objective 2:

Given access to various types of farm maintenance equipment which has been used to make the farm site more productive, safe and attractive, the student will lubricate, clean and store farm maintenance equipment by following recommendations in the appropriate service manuals so that farm maintenance equipment will operate safely and efficiently when used to maintain the farm site.

Instructional Areas:

1. Lubricating and servicing farm maintenance machinery
    a. Disengaging power and stopping machine
    b. Following all recommendations in service manual in lubricating and servicing equipment
        (1) Lubricating all pressure-type fittings
        (2) Oiling all moving parts
        (3) Adjusting wheel bearings
        (4) Checking tire inflation
        (5) Tightening all bolts and screws
        (6) Replacing all worn parts
    c. Using containers to store removed parts
    d. Protecting self from sharp edges and protruding parts
    e. Cleaning up spilled oil, grease and fuel
2. Cleaning various farm maintenance equipment
    a. Removing all dirt, saw dust and other material from the equipment
    b. Using solvent to clean grease and dirt that will not otherwise come off

3. Storing various farm maintenance equipment

    a. Cleaning exterior of machine
    b. Cleaning and repacking wheel bearings where appropriate
    c. Parking or placing machine in storage location
    d. Releasing tension on all drive belts and chains
    e. Applying grease or rust preventive to chains
    f. Coating all exposed metal surfaces with grease or rust preventive
    g. Lubricating all points normally requiring lubrication
    h. Checking equipment and making list of parts or repairs to make the machine ready for operation
    i. Cleaning off rust and painting where appropriate
    j. Covering machine with a canvas if not stored inside a building

Examples of Supporting References:

In addition to references listed in Student Performance Objective 1, the following may be useful:

1. Fundamentals of Machine Operation - Preventive Maintenance. Moline, Illinois: John Deere and Company. 1973

Examples of Student Learning Activities:

1. Given a power mower, the instructor may ask a student to prepare a report on the regular maintenance necessary to keep the machine in good working order.

2. Given a chain saw after use, the instructor may ask two students to clean the saw dust and oil from the machine.

Examples of Evaluation Techniques:

1. Given a rotary type mower to be stored for the winter, the student will describe at least five things that should be done to the machinery for proper storage.

2. Given grease that has been spilled on a cement floor during the servicing of a machine, the student will clean the grease up in such a way that the spot is not slippery or dangerous to walk on.

Instructional Resources:

1. Access to various items of farm maintenance equipment which the student can lubricate and service
2. Appropriate lubricants and lubricating equipment
3. Solvent for cleaning up grease and oil
4. Old clean cloths
5. Scrapers used for cleaning off dirt

APPENDIX A

AN EXAMPLE OF THE FORMAT USED FOR WRITING STUDENT TERMINAL PERFORMANCE OBJECTIVES

MUSKEGON AREA INTERMEDIATE SCHOOL DISTRICT
VOCATIONAL AND TECHNICAL AGRICULTURE RESEARCH PROJECT PERFORMANCE OBJECTIVES

Occupational
Designation: Farm Manager

U.S.O.E. CODE
NUMBER: 01.0104

MODULE TOPIC	CONDITIONS	PERFORMANCE	CRITERIA
FULFILLING FARM TAX RESPONSIBILITIES	1. Given complete annual farm account records for a specific farm and information regarding the farm family and the appropriate forms and instruction books	the student will complete the state income tax report for the farm using the appropriate tax rate schedules and records including necessary supporting data	to the satisfaction of the instructor with 100% accuracy
	2. Given complete annual farm account records for a specific farm and information regarding the farm family and appropriate forms	the student will complete the federal income tax report for the farm using the appropriate tax rate schedules and records including necessary supporting data	to the satisfaction of the instructor and with 100% accuracy

APPENDIX B

LISTING OF INDIVIDUALS WHO REVIEWED STUDENT PERFORMANCE OBJECTIVES AND INSTRUCTIONAL MODULES

REVIEWERS OF STUDENT PERFORMANCE OBJECTIVES AND INSTRUCTIONAL MODULES

Name	Position, Address
Mr. Philip Carter	Instructor of Vocational Agriculture Shelby, Michigan
Dr. Raymond M. Clark	Consultant Michigan State University East Lansing, Michigan
Dr. Y.A. Demirjian	Director Muskegon County Wastewater Management System Muskegon, Michigan
Mr. Keith Griffin	Instructor of Vocational Agriculture Montague, Michigan
Mr. Richard Hopson	Chemistry Instructor Muskegon Community College Muskegon, Michigan
Mr. James Kane	Biology Instructor Muskegon Community College Muskegon, Michigan
Mr. Claude Premo	Biology Instructor Muskegon Community College Muskegon, Michigan
Mr. Michael Strazanac	Welding Instructor Muskegon Community College Muskegon, Michigan
Mr. Walter Weber	Instructor of Vocational Agriculture Ravenna, Michigan
Mr. Timothy Westman	Laboratory Director Muskegon County Wastewater Management System Muskegon, Michigan

APPENDIX C

AN EXPLANATION OF THE COMPONENTS IN THE INSTRUCTIONAL MODULES

COMPONENTS OF THE INSTRUCTIONAL MODULES

Each of the modules consist of the following components:

1. Module Concept
2. Prerequisites
3. Module Goal
4. Student Terminal Performance Objectives. Each performance objective has these sections:
   a. Instructional Areas
   b. Examples of Supporting References
   c. Examples of Student Learning Activities
   d. Examples of Evaluation Techniques
   e. Instructional Resources

A Description of the Module Concept:

The module concept consists of a synopsis of the module material and what the student will be studying. It depicts the relevance of the subject material and explanations of why the student should study the material. The module concept particularly explains how the module is related to the student occupational program.

Prerequisites:

Prerequisites provide the teacher with information in regard to what the learner should know or be able to do before pursuing the module.

The Module Goal:

The Module Goal was written in a broad sense to indicate the competency of the student upon completion of a module.

Student Terminal Performance Objectives

Student Terminal Performance Objectives are descriptions of intended outcomes which require the acquisition of certain knowledge and skills. Student terminal performance objectives were written to describe in detail various aspects of the module goal. Several student terminal performance objectives were written so that the student will be capable of performing the module goal effectively. The condition, performance, and criteria were established for each student terminal performance objective. Each student terminal performance objective possesses the following elements:

1. Instructional Areas. Titles and subtitles of instructional areas were written to define the relevant content that should be covered by the instructor.
2. Examples of Supporting References. Examples of supporting references were included in the module to assist the instructor in accomplishing the desired performance of the student.
3. Examples of Student Learning Activities. Examples of student learning activities were written so that the student may become actively involved in various activities that will assist him or her in achieving the student terminal performance objectives.
4. Evaluation Techniques. Suggested evaluation techniques were written to assist the instructor in determining how well the student should perform the student terminal performance objective under specified conditions.
5. Instructional Resources. Instructional materials and/or equipment which are specific to the modules and essential to enhance the learning of students were listed.

APPENDIX D

A LISTING OF INDUSTRIES AND AGENCIES WHO PROVIDED THE STAFF WITH RELATED PROJECT MATERIALS

INDUSTRIES

Allis - Chalmers
Milwaukee, Wisconsin

Aqua - Aerobic Systems
Rockford, Illinois

Briggs and Stratton Corporation
Milwaukee, Wisconsin

Chemineer Agitators Company
Dayton, Ohio

Ford Motor Company
Ford Tractor Division
Birmingham, Michigan

General Electric Company
Bloomington, Illinois

John Deere and Company
Moline, Illinois

Lockwood Corporation
Gering, Nebraska

Minneapolis - Moline
Hopkins, Minnesota

Oliver Corporation
South Bend, Indiana

Pennwalt Corporation
Belleville, New Jersey

White Farm Equipment Company
Charles City, Iowa

White Motor Corporation
Oak Brook, Illinois

GOVERNMENTAL AGENCIES

Michigan Department of Agriculture
Lansing, Michigan

Michigan Department of Public Health
Lansing, Michigan

Michigan State University Cooperative
Extension Service
East Lansing, Michigan

Michigan Department of Natural Resources
Lansing, Michigan

New York State Department of Health
Albany, New York

New York State Education Department
Albany, New York

Oklahoma State Department of Vocational
and Technical Education
Stilwater, Oklahoma

Oregon Department of Education
Salem, Oregon

Texas State Department of Health
Austin, Texas

United State Department of Agriculture
Washington, D.C.

United State Department of Health, Education,
and Welfare
Washington, D.C.

United States Department of Labor
Washington, D.C.

United States Environmental Protection Agency
Washington, D.C.

United States Office of Soil Conservation Service
Washington, D.C.

Water Pollution Control Federation
Washington, D.C.

COLLEGES AND UNIVERSITIES

Clemson University
Clemson, South Carolina

Michigan State University
East Lansing, Michigan

Montana State University
Bozeman, Montana

The Ohio State University
Columbus, Ohio

Sacramento State College
Sacramento, California

The University of Michigan
Ann Arbor, Michigan